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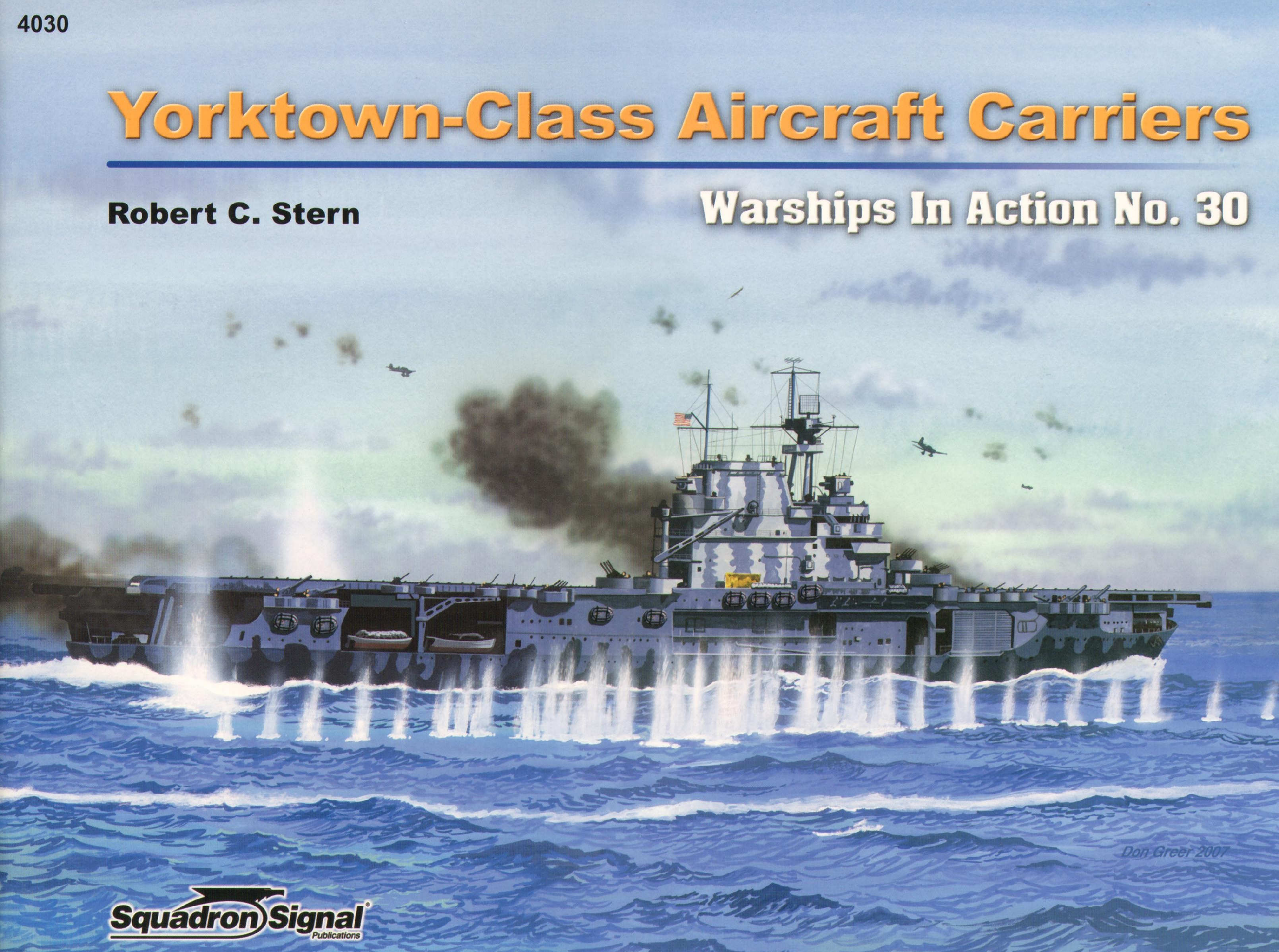
Yorktown-Class Aircraft Carriers

Robert C. Stern

Warships In Action No. 30



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Written by Robert C. Stern

Cover Paintings and Profiles
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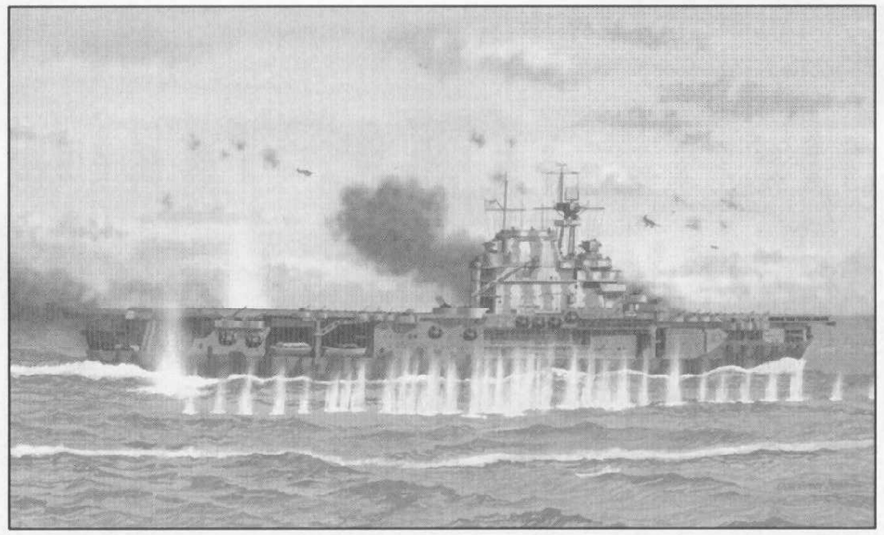
Squadron Signal Publications



(Front Cover) Hornet (CV 8) fights for her life at the Battle of Santa Cruz, 26 October 1942. During the first wave of Japanese attacks, she was hit by three bombs, two crashing aircraft, and two torpedoes. She is painted in the Measure (Ms) 12 Mod scheme intended to be most effective against surface opponents.

(Back Cover) Enterprise (CV 6) steams soon after receiving her 1.1-inch anti-aircraft guns, covered with tarpaulins to protect their rather delicate mechanisms, April 1939. The pale wood flight deck has received a fresh coat of reddish-brown stain. This would fade to a rich, dark tan after only a few months.

(Preceding Page) The sky was full of puffs of black flak explosions as Japanese Val dive bombers try to knock *Enterprise* out of the war in the last of the great carrier battles of 1942, the Battle of Santa Cruz on 26 October 1942. A pair of the dive bombers can be seen — one directly above the carrier and a second pulling up to the right. A bomb splash subsides just aft of *Enterprise*. The two U.S. ships in the right of the photo are (left) a *Mahan*-class destroyer and *South Dakota* (BB 57). The white flash from the battleship is coming from one of her 5-inch/38 guns. This was during the first attack, when *Enterprise* was hit by two bombs and near-missed by a third, causing extensive damage; flight operations were not impeded. *(NARA)*

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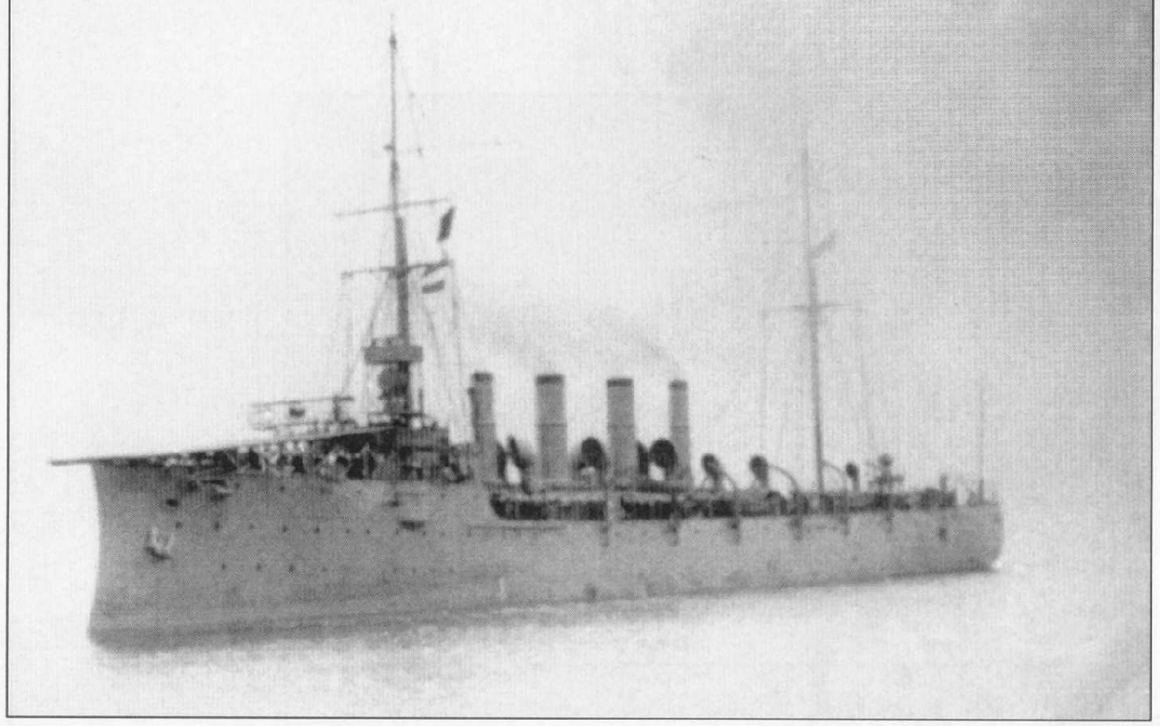
Acknowledgements

The photographs all come from the U.S. Navy originally, but they arrived in my collection by various routes and reside now in several different archives. The credit given with each photograph is the organization that gave, sold, or allowed me to copy the photographs used in this book. I wish to thank them and their unfailingly helpful staffs, which have made these wonderful photographs available.

U.S. National Archives and Records Administration, College Park, Maryland (NARA)
Naval Historical Center, Washington, D.C. (NHC)
National Air & Space Museum, Washington, D.C. (NASM)

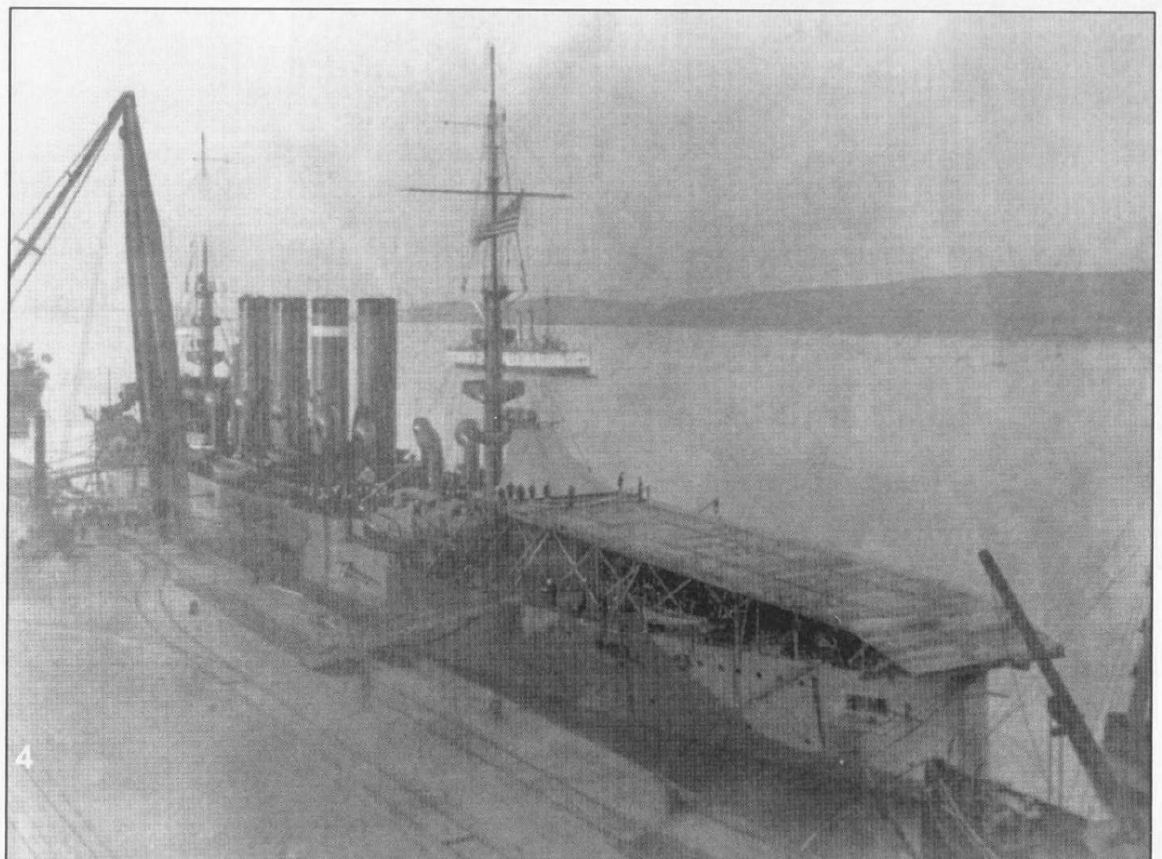
I also wish to direct anyone seeking more information on the *Yorktowns* to the excellent Web site www.cv6.org, which has many great photographs and a detailed history of *Enterprise*. A particular thanks is due to Joel Shepherd, webmaster of that site, for permission to use several photographs from that site.

A TBD-1 of Torpedo Squadron 5 (VT-5), 5-T-11, came to grief trapping on *Yorktown* (CV 5), 3 September 1940. Even though Europe had been at war a full year, American carrier aircraft carried full peacetime markings. This Devastator's tail was painted Insignia Red, as were all of *Yorktown*'s aircraft. The fuselage was painted gloss gray, the wing upper surfaces chrome yellow, the chevron gloss black, and the nonskid strip dull black. *Yorktown* was still painted overall Haze Gray (5-H). Her big aircraft crane at the aft end of the island is in stowed position. Number 3 1.1-inch mount is outboard of the crane on a raised platform. *(NARA)*



The U.S. Navy was the first to experiment with flying wheeled aircraft onto and off warships. Launching early aircraft from ships was relatively easy. The setup on *Birmingham* (CL 2) involved little more than a sloping ramp over the bow, 14 November 1910. A civilian aviator, Eugene B. Ely, is seen poised to attempt the launching of his Curtiss biplane from the stationary cruiser in the Chesapeake Bay. The attempt was successful, but without a means of landing back on the cruiser, Ely had no choice but to head for land once he was airborne. *(NARA)*

The armored cruiser *Pennsylvania* (ACR 4) was used for several experiments in the winter of 1910–11, involving both landing on and subsequently taking off from the platform built over the cruiser's stern. The same pilot flew the same Curtiss "Hudson Flyer" on 18 January 1911 in San Francisco Bay. *(NARA)*



Aircraft Carriers for the U.S. Navy

The U.S. Navy was notorious for experimenting with promising technologies and then failing to follow up the early lead over rival powers. One well-known example is in submarine development, in which the Americans had a clear early lead thanks to the work of John Holland, but by the end of World War I found themselves producing submarines that were barely second-rate. A similar course was followed with regard to naval aviation. After leading the world with the first take-off from and landing of a "heavier-than-air" craft on a ship, the U.S. Navy then became distracted by the apparent advantages of float planes and let that lead slip away as well.

The advantages of float planes that appealed to the conservative faction in the Navy, by far the majority group at the beginning of the 20th century, included the fact that almost any large ship could launch a float plane from a catapult and recover it anywhere there was an unobstructed stretch of water. Unfortunately, the advocates of float planes overlooked their many serious disadvantages. These included the fact that float planes could only land on calm water, and the recovery ship would need to stop for an extended period of time while recovering the aircraft from the water. Even if these problems could be addressed, the simple fact was that the floats would always be a source of aerodynamic drag that would make a float plane slower and less maneuverable than an aircraft without floats.

Simple and Irrefutable Logic Prevails

Ultimately it was this fact that finally convinced the U.S. Navy to look again at building ships capable of launching and recovering wheeled aircraft. The logic was simple and irrefutable. The uses most often put forward for having aircraft with the fleet in the first place — scouting ahead of the fleet to find the enemy and spotting the fall of shot once the battle was joined — could be achieved equally by float planes or wheeled aircraft. But, if both sides in an encounter had aircraft aloft over a disputed patch of water, each side's aircraft would obviously attempt to deny the enemy the advantages that having aircraft brought. Inevitably that meant that naval aircraft would be armed and would attempt to shoot down any enemy aircraft they came across. In this kind of encounter if one side were flying float planes and the other wheeled aircraft, the side with the wheeled aircraft would be by far the most likely to prevail.

Looking around at the end of World War I, it was easy to see that the rest of the world hadn't stood still while the U.S. Navy flirted with float planes. The Royal Navy, which had a specific need to put fighters in the air over the North Sea — to attempt to shoot down zeppelins before they could reach England — had one large aircraft carrier in service and three more under construction at the end of the war. While the Americans considered the British a firm ally and thus no direct threat to the United States, there was no telling whether that would be a permanent condition. Anyway, even if the British remained friendly, other nations less well disposed to the United States were known to be interested in naval aviation.

Again playing catch-up with the rest of the world, the U.S. Navy authorized the experimental conversion of the new collier (a ship for transporting coal) *Jupiter* in July 1919. Even this step was controversial with the conservative "Big Gun Club" of battleship admirals, who protested that they needed a fast collier more than they needed a slow aircraft carrier. The move was timely, as the Japanese, the nation even then considered to be the most likely opponent should America go to war again, started construction of the purpose-built aircraft carrier *Hosho* in December of the same year. The French were also known to be planning an aircraft carrier, to be built on the incomplete hull of the battleship *Béarn*. The ship the Americans built on the hull of *Jupiter* was small and slow, but with her commissioning as *Langley* (CV 1) in 1922, the U.S. Navy had its first working aircraft carrier with which to learn how to operate aircraft at sea. (The U.S. Navy gave its ships hull number designations consisting of a type identifier, most often but not always two letters, and a one-up sequence number based on the order the hulls were ordered. The "C" in "CV" refers to the fact that aircraft carriers were considered at first to be a

sub-type of cruiser. Several different stories have been put forward to explain the "V." One is that it stands for "heaVier-than-air," a term used to differentiate early aircraft from airships. Another is that it derives from "aViation." The most believable is that it was a randomly chosen letter.)

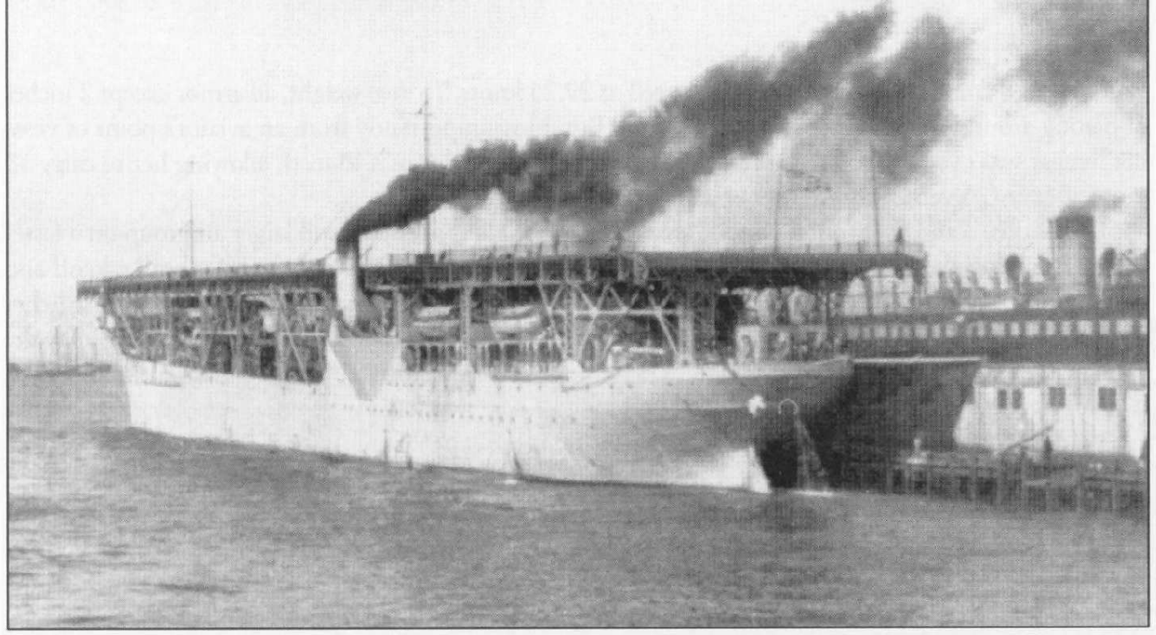
The arms limitation process starting with the Washington Treaty of 1921–22 led to the plan to convert the incomplete battlecruisers *Lexington* and *Saratoga* to aircraft carriers. These gave the U.S. Navy a pair of large, fast carriers that should have set the standard for future development. That it didn't work out that way was at least in part due to the fact that the treaty limited not only the size of specific ship types, but also the total tonnage a nation could build of any type of ship. While the United States was pleased that the treaty process limited the Japanese to three-fifths of the tonnage allowed the Americans and British, they were less happy with the absolute limit of 135,000 tons on total aircraft carrier tonnage and 33,000 tons per ship. With the launch of *Lexington* (CV 2) and *Saratoga* (CV 3), each nominally displacing the maximum allowable tonnage, and not counting *Langley*, the U.S. Navy would have only 69,000 tons left under the limit.

Circumventing Weight Limits

The decision not to count *Langley* was based on a provision in the Washington Treaty that allowed the exclusion of carriers considered experimental or built before 1921. This was somewhat controversial, because *Langley* was being treated as an operational warship at the time these discussions were taking place, and while she was in service as a collier well before 1921, she wasn't commissioned as an aircraft carrier until March 1922. Arriving at a treaty displacement of 33,000 tons for the *Lexingtons* when in fact they displaced considerably more than that was even more iffy. The United States invoked a treaty provision that allowed the addition of 3,000 tons of anti-torpedo or anti-aircraft protection to pre-existing ships, even though this tonnage was being added to the *Lexingtons* while they were still under construction. Even accepting this questionable claim, the *Lexingtons* exceeded their allowed tonnage by at least 1,500 tons. The United States was by no means the only nation to build ships displacing more than their allowed tonnage, but it was by far the most vocal in its public outrage at other nations' bending of the rules.

The discussion concerning how to use the remaining allowable tonnage was often heated, especially before 1928 when the *Lexingtons* joined the fleet. There was general agreement that these two ships were larger than they had to be. Despite the removal of most of their battlecruiser features, there was a good deal of unnecessary inner structure that just added weight. Their long and narrow hulls also contained a lot of unusable space, particularly at the bow and stern. Everyone agreed that a carrier as good or better than a *Lexington* could be built on a smaller displacement. The disagreement was over just how small an aircraft carrier could be and still carry an adequate air group and survive inevitable battle damage. The available tonnage could be used to build three carriers of 23,000 tons, four of 17,250 tons, or five of 13,800 tons, and there were proponents of each of these options. Those in favor of the largest size claimed that fewer, more capable ships were better than more hulls with significantly smaller air groups. The proponents of the smallest option claimed that having more hulls in the water made for a greater chance that some intact flight decks would survive an enemy attack. The supporters of the intermediate size claimed simply that this represented the best compromise between the two extremes and gave the best combination of offensive power and survivability. These arguments were taking place in the mid- to late-1920s, much of them before the fleet had any real experience operating the *Lexingtons*. Congress and the slow but steady momentum of the appropriations process forced the Navy to act before that experience was in hand. Funds were allocated in the FY29 budget for the first purpose-built American aircraft carrier.

Thus the design of *Ranger* (CV 4) was drawn up based on experience only with *Langley* and nearly a decade of inconclusive argument over the ideal features of an aircraft carrier. Forced to make a decision, the Navy opted for the smallest of the three competing approaches. When ultimately launched in 1933, she weighed in at 14,575 tons, nearly 800 tons over the original design displacement, mainly due to the decision to add a small island structure to the original flush-deck design. She was 730 feet long at the



Langley (CV 1) started life as a collier (a ship for transporting coal), but was converted to an aircraft carrier in 1920–22. She is seen soon after rejoining the fleet, 6 January 1923. Her hangar area, under the flight deck, was open to the weather. She had no island structure, and her single funnel folded down during flight operations, both concessions to the aviation community that wanted no obstructions to the flight deck. The large structure on her fantail is a pigeon coop, part of a failed experiment with homing pigeons in the days before aircraft carried radios. *(NARA)*

Lexington (CV 2) and *Saratoga* (CV 3) were also conversions, but were much larger than *Langley* and allowed the U.S. Navy to gain experience with full-size aircraft carriers. *Saratoga*, at San Diego on 7 November 1931, was so similar to her sister that she adopted two visual cues to help pilots differentiate her — the name painted across the ramp at the aft end of her flight deck and the broad black stripe on her funnel. Experience with *Langley* convinced her designers of the utility of an island structure with a funnel tall enough to carry smoke and gases away from the flight deck. *(NARA)*

waterline and could travel at a maximum speed of 29.25 knots. To save weight, all armor except 2 inches of plating around her steering gear was omitted. But, most importantly from an aviator's point of view, her hangar was over 100 feet longer than *Lexington*'s (552 feet versus 440 feet), allowing her to carry 13 more aircraft (76 versus 63) in her nominal air group.

For all this, *Ranger* was not a popular ship. The Navy's fliers wanted a still larger air group on a faster ship. (The faster the aircraft carrier, the greater the "wind over the deck," and the safer both takeoff and landings operations were for fliers.) In the opinion of her critics, her near-total lack of armor made her too vulnerable to damage by light weapons. Also, she was just short enough to be adversely affected by the long swells common in the Pacific, making her prone to pitch excessively in all but the calmest seas. This, plus several years of accumulated experience with the *Lexingtons*, gave weight to the aviators' insistence that the next aircraft carrier built had to be bigger and more capable than *Ranger*.

Taking *Ranger* into account, the U.S. Navy now had 55,000 tons remaining under the treaty limits. This could be used by building two carriers of 27,500 tons or three of 18,300 tons. This time there was near universal agreement that carriers in the former category would have been bigger than was needed, and those in the latter would have been too small. It was also agreed, based on experience with the *Lexingtons*, that aircraft carriers should operate in groups of two similar platforms. (There were several reasons for this, the most obvious that in case one of the two was damaged, pilots could operate off either carrier without a problem.) This led to a clever compromise — a second *Ranger*-sized carrier would be built to form a task group, and two larger ships of 20,700 tons would form the Navy's third pair of aircraft carriers. These two would become *Yorktown* (CV 5) and *Enterprise* (CV 6).

Naming Conventions

The naming of American aircraft carriers is curious. Some have been named after people. *Langley* was named for a pioneer of naval aviation, Samuel Langley; other, later U.S. aircraft carriers were named after men important in American history, such as Benjamin Franklin and John Hancock. When the next two U.S. carriers were converted from battlecruiser hulls, they carried their original names with them and most American aircraft carriers continued the naming rules decreed for battlecruisers, which were to be named for famous battles in American history (e.g., *Lexington*, *Saratoga*, and *Yorktown*) or famous naval vessels (e.g., *Ranger*, *Enterprise*, *Wasp* [CV 7], and *Hornet* [CV 8]). The current habit of naming aircraft carriers for recent politicians of questionable importance (e.g., *Carl Vinson* [CVN 70] and *John C. Stennis* [CVN 74]) somewhat degrades this noble pattern.

The characteristics of these two larger carriers were first laid out in a Bureau of Aeronautics (BuAer) proposal of May 1931. This would have been a ship of 20,700 tons, a length of 775 feet on the waterline, a speed of 32.5 knots, armor to protect against 6-inch gunfire, and an air group of 90 aircraft. This proved to be remarkably close to the characteristics of the design that eventually emerged.

The following are the dimensions of *Enterprise* as built. (Note that *Yorktown* and *Enterprise* were essentially identical in all significant dimensions, while *Hornet* differed somewhat in some of these specifications.)

Displacement (standard) .....19,875 tons
Waterline length .....770 feet 0 inches
Length overall .....809 feet 6 inches
Length flight deck .....802 feet 0 inches
Beam at waterline .....83 feet 2.5 inches
Width flight deck .....86 feet 0 inches
Draft .....25 feet 11 inches
Power (trial) .....120,517 shaft horsepower (shp)
Speed (trial) .....33.65 knots
Air group .....96 aircraft

The *Yorktowns* had a large island that included the funnels to the starboard side of the flight deck, modeled after the structure on the *Lexingtons*. (The experiment with folding funnels tried on *Langley* and *Ranger* was not repeated.) As built, they carried eight 5-inch/38-caliber single mounts located in pairs in sponsons (projections from the side of a ship) forward and aft on each side; and 24 .50-caliber M2 Browning machine guns in water-cooled single mounts, 16 in four sponsons along the edge of the flight deck, four in the foremast fighting top, and two each fore and aft of the funnel. A pair of "cruiser-type" Mk 33 fire control directors were provided for anti-aircraft control of the 5-inch battery. The 5-inch guns were considered a dual-purpose mount and were intended to defend the ships from surface as well as airborne threats. To direct the 5-inch battery in a surface engagement, a 15-foot rangefinder was on top of the pilothouse.

Landing or Launching From Either End of the Flight Deck

More importantly from the point of view of aircraft handling, the *Yorktowns* were designed with three large elevators to carry aircraft between the flight deck and the single hangar deck. They also had three H-II catapults, two at the bow of the flight deck and one athwartships forward at the hangar deck level. The *Yorktowns* were designed to be "double-ended," meaning they could land or launch aircraft off either end of the flight deck. The idea was that the ships should be able to continue operating aircraft with flight deck damage fore or aft. The practical implications were that their engineering plant had to be capable of operating at 20 knots stern-first and the flight deck equipped to land aircraft over the bow. To permit this, the *Yorktowns* had, besides nine arresting wires aft of the amidships elevator, another complete set of wires forward spaced out almost all the way to the bow in order to trap aircraft coming from ahead. Additionally, there were nine crash barriers fore and aft to protect parked planes from a missed trap.

Armor was provided in the form of three heavy torpedo bulkheads of 30-pound mild nickel steel (each equivalent to 0.42 inches of armor) behind a narrow armor belt that varied from 3.25 inches in way of the magazines forward to 2.75 inches alongside the engineering spaces farther aft (where there was more air space between the torpedo bulkheads). This was considered equivalent to 4 inches of armor along the length of the ship, sufficient to meet the requirement to protect against 6-inch gunfire. This scheme was topped by a protective deck of 60-pound Special Treatment Steel (STS) that thinned to 40 pounds outside of the middle bulkhead. This was at the fourth deck level, just barely above the full-load waterline. A longitudinal bulkhead ran most of the length of the ship between the third and fourth decks to slow down flooding in case damage to the side protective system extended above the belt. (The addition of a second protective deck at the flight deck or hangar deck level was debated but rejected for weight and stability reasons. An armored hangar deck was added to the *Essex*-class design, which greatly enhanced the ships' ability to survive kamikaze attacks.)

Design Flaw

This side protective system was designed to protect against the explosion of a warhead equivalent to 400 pounds of TNT against the side of the hull. However, the weapon that would be launched against *Yorktown* at Midway and *Hornet* at Santa Cruz was the Japanese Type 91 Mod 3 aerial torpedo that carried a 529-pound warhead. The odds were high that a direct hit by this torpedo would defeat the protective system and cause massive flooding. Events were to prove that this wasn't the most serious weakness in the design of the *Yorktowns*. These ships were built with three contiguous transverse rows of three boiler rooms followed by the four engine rooms. Even at the time *Yorktown* was designed, this was recognized as dangerous because of the risk that a single torpedo could knock out most or all of the ship's power. The decision not to alternate these engineering spaces was made on the grounds of weight savings — alternating boiler and engine rooms requires longer exhaust trunking and propeller shafts, both of which add weight. (It

is worth noting that when *Wasp* was designed, she was given alternating engineering spaces; when *Hornet* was ordered, at a time that weight was no longer a serious issue, consideration was given to modifying the *Yorktown* design to include this feature, but it was rejected because of the delay this redesign would cause.)

Work was begun on the contract plans for *Yorktown* in March 1932 but halted due to the need to develop plans for an authorized heavy cruiser. Money for *Yorktown* and *Enterprise* wasn't authorized until June 1933, and the first of the class wasn't laid down until May 1934.

With the two authorized *Yorktowns* in hand, the U.S. Navy addressed the "expenditure" of the remaining available treaty tonnage. This was a complex issue. The Vinson-Trammell Act of 1934, which authorized the Navy to build up to the limits allowed by the Washington Treaty, also specifically required that the Navy abide scrupulously by all treaty provisions, which included counting *Langley* in when figuring available carrier tonnage. Only by actually decommissioning *Langley* was tonnage freed up to order the smaller *Wasp* in 1934 as a "half-sister" to *Ranger*.

The Class's Half-Sister

Wasp was more successful than *Ranger*, but still not the carrier the Navy wanted. She had a more built-up tower/funnel structure than *Ranger*, similar to *Yorktown*'s, four catapults (two on the flight deck and two on the hangar deck), and three elevators. The arrangement of elevators was innovative in that only two were on the centerline; the third was a skeletal structure at the deck edge on the port side, forward of the island. She had provisions for an armor belt, but none was fitted during construction due to weight considerations, and the planned installation after the Washington Treaty expired in 1938 was never carried out, as time and materials were never available at the same time.

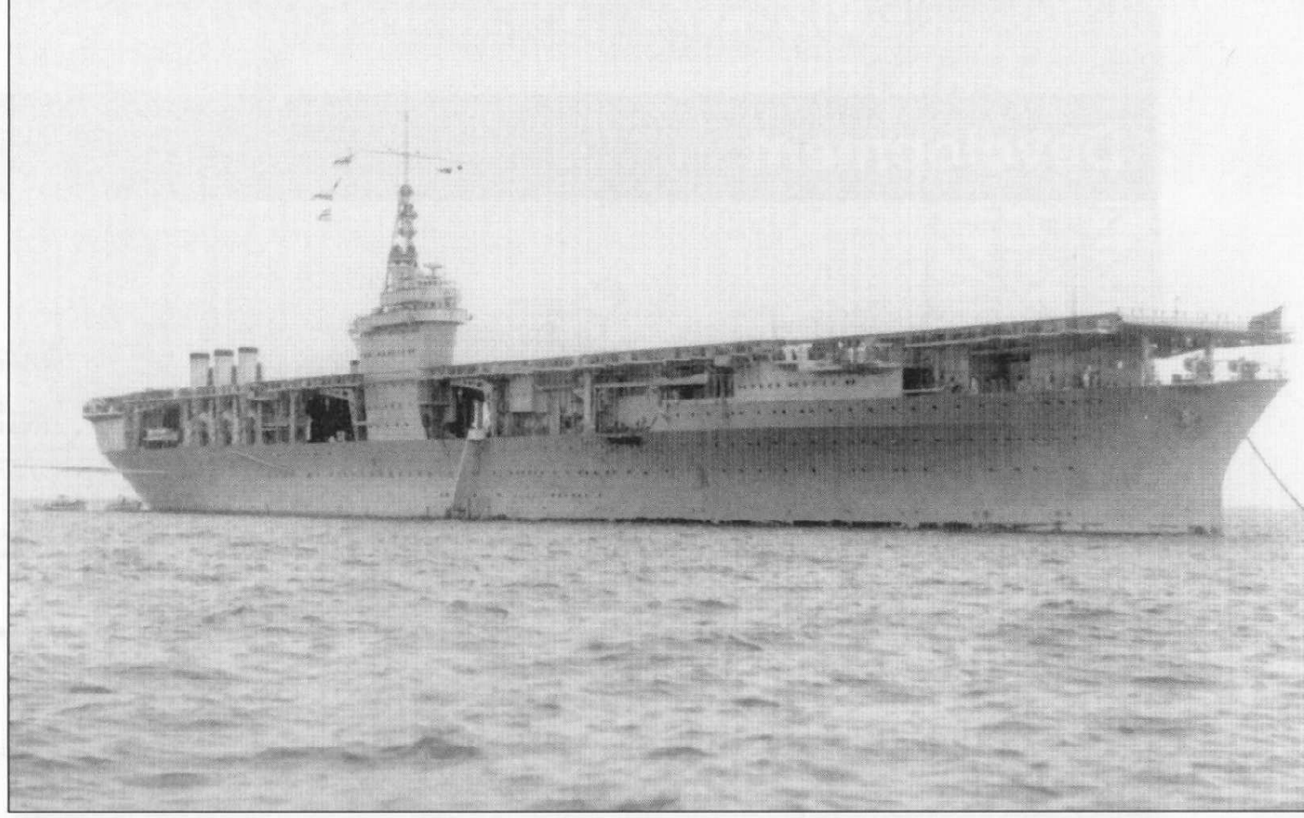
This should have ended the story. With the pending expiration of the Washington Treaty, the Navy began the preliminary design process that ended with the ordering of the first *Essex*-class carriers in 1940. As pleased as the Navy was with the *Yorktowns*, they ultimately represented a compromise brought about by the need to comply with the treaty. Ideally, the Navy wanted the next aircraft carrier built to be an "improved *Yorktown*," freed from all treaty limitations. The next aircraft carrier would displace almost 40 percent more than the *Yorktowns*, be 80 feet longer, better armed and armored, and carry an even bigger air group. The money for this carrier was authorized in 1939. Everything appeared to be set for the Navy to get the carrier it really wanted.

The only problem was that there were other projects in line ahead of this new aircraft carrier for the Navy's limited design capability. It would be a year before detail drawings could even be begun on the "improved *Yorktown*." The choice was to wait at least a year and a half before laying the keel of the next aircraft carrier or use an existing design. Work began on a third *Yorktown*, *Hornet*, in September 1939. It would be 19 months before the keel was laid on *Essex* (CV 9).

Hornet Visually Different

There were minor improvements made to *Hornet* that distinguished her visually from her sisters. She had a lighter foretop and carried "destroyer-type" Mk 37 fire control directors in the place of the larger Mk 33 directors. Her flight deck was slightly longer, 824 feet 9 inches. Other than that, there wasn't much difference from *Yorktown* and *Enterprise*.

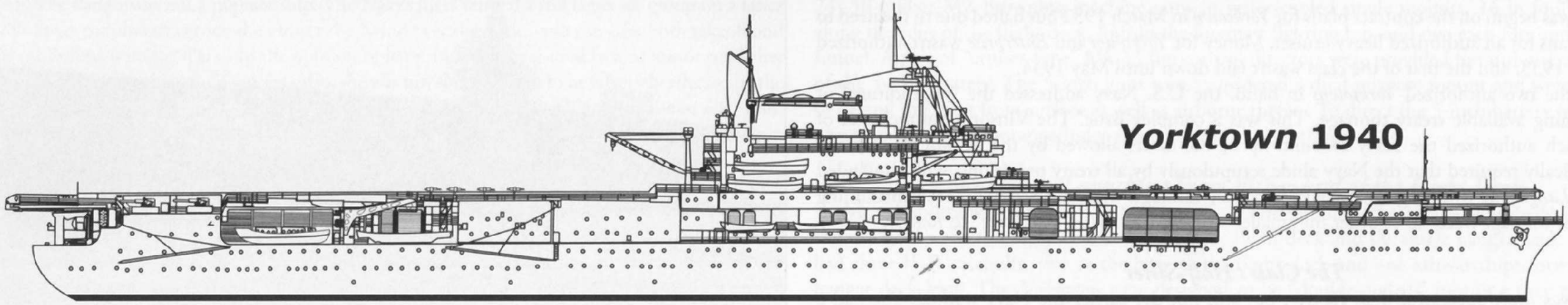
Hornet was still working up on the East Coast, less than two months in commission, when war broke out. She was hurried to the Pacific and joined her two sisters in carrying the main load of the fighting in the first year of the war. The three *Yorktowns* fought together only once, at Midway. This would sadly be the only they time they could do so, because *Yorktown* was lost in that battle. *Hornet* sank not many months later at the Battle of Santa Cruz. *Enterprise* fought on, surviving to become obsolete by the end of the war she and her sisters had done so much to win.

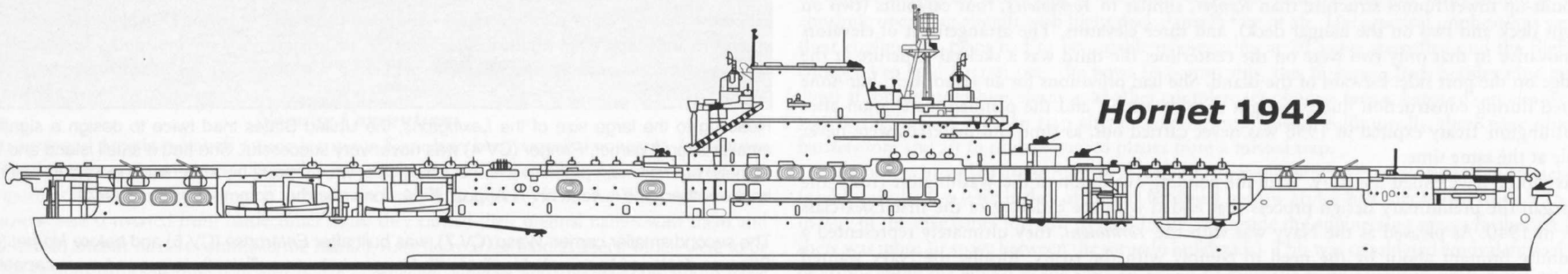


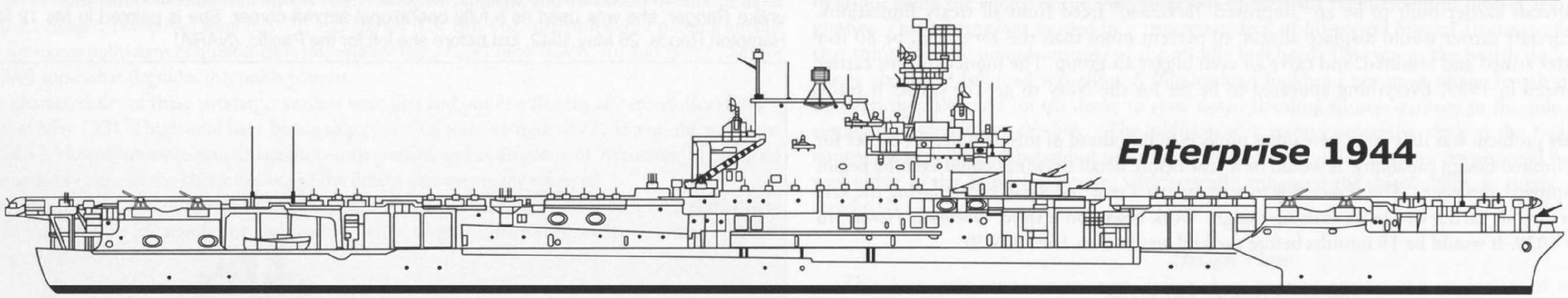
Reacting to the large size of the *Lexingtons*, the United States tried twice to design a significantly smaller aircraft carrier. *Ranger* (CV 4) was never very successful. She had a small island and folding funnels, but her main problem was her small size, which made her difficult to operate in any but the best weather. She is seen on 11 August 1934, soon after her commissioning. *(NARA)*

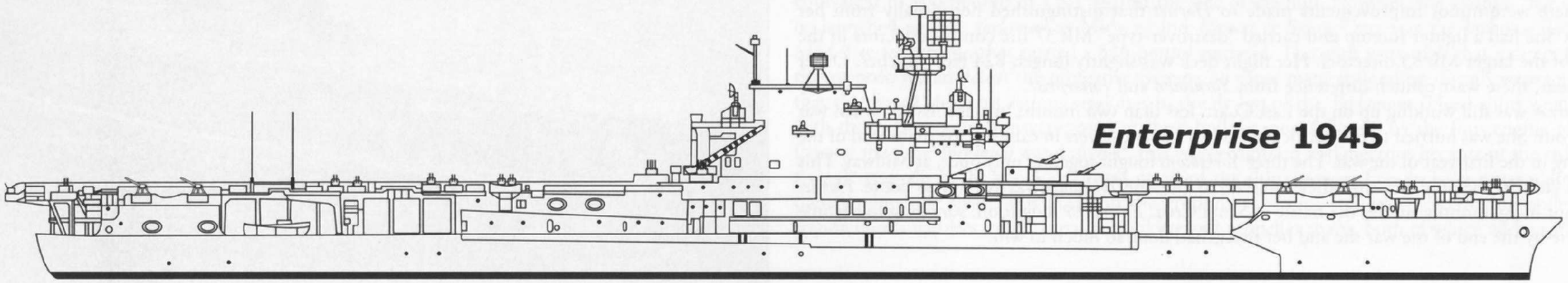
The second smaller carrier, *Wasp* (CV 7), was built after *Enterprise* (CV 6) and before *Hornet* (CV 8). She was designed to operate together with *Ranger*, but was sufficiently larger and more capable that, unlike *Ranger*, she was used as a fully operational aircraft carrier. She is painted in Ms 12 Mod off Hampton Roads, 26 May 1942, just before she left for the Pacific. *(NARA)*

Development









Yorktown (CV 5)

Named for the Revolutionary War battle at Yorktown, Virginia, CV 5 was laid down on 21 May 1934 at the Newport News Shipbuilding and Dry Dock Co., appropriately enough not many miles from the site of the battle for which she was named. *Yorktown* was launched on 4 April 1936, sponsored by Eleanor Roosevelt. She was commissioned into the fleet at Norfolk on 30 September 1937.

In her "as-built" condition, she was armed with weapons considered capable of fighting off enemy light forces; however, the intended employment of aircraft carriers well away from any surface engagement and her high speed compared to all but the fastest opponents were considered her best protection against enemy surface forces. It was well understood, even in the 1930s, that enemy aircraft would be the primary threat to *Yorktown*, and it was against this threat that her armament was primarily designed. Her largest weapons were eight 5-inch/38 Mk 21 Mod 16 guns in single open pedestal mounts, located two each fore and aft on either side of the flight deck. These were well-designed dual-purpose weapons, capable of firing a variety of armor piercing (AP), high capacity (HC), anti-aircraft (AA), and illumination shells. The typical loadout for *Yorktown* would be 450 rounds per gun, almost entirely AA Common, with a small number of starshells. (In naval parlance, a "common" round normally had a bursting charge somewhere in between that found in an HC shell, which would be typically used for shore bombardment, and an AP shell, which would be used against ships. Common rounds were also known as "Semi-Armor Piercing" or SAP rounds. In the case of the 5-inch/38, the AA Common had the same charge, 7.6 pounds, as the HC.) These were considered the largest hand-loadable weapons in the fleet. Each shell weighed 54.39 pounds for the illumination round and 55.2 pounds for the AA Common round, allowing a rate of fire of between 12 and 15 rounds per minute (rpm), depending on the target and the proficiency of the gun crew.

The AA Common round had a contact detonation base fuse and a time-set nose fuse. When used against aircraft, the nose fuse would be set to explode at a predetermined time after the round was fired. This translated into a particular altitude based on the elevation of the gun and whether the barrel was new or worn. For example, at a muzzle velocity of 2,500 feet per second (fps), average for this gun in mid-barrel life, a round would travel 15,000 feet in 8 seconds and 30,000 feet in 22 seconds when fired horizontally.

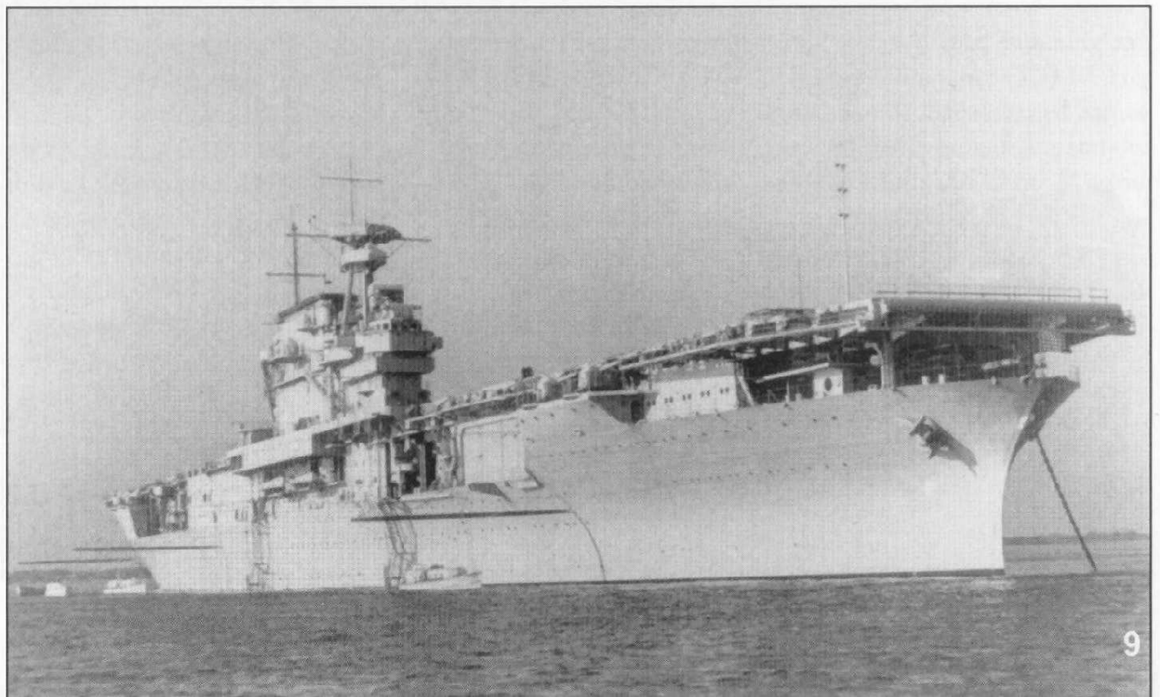
Firing Her 5-Inch/38 Guns

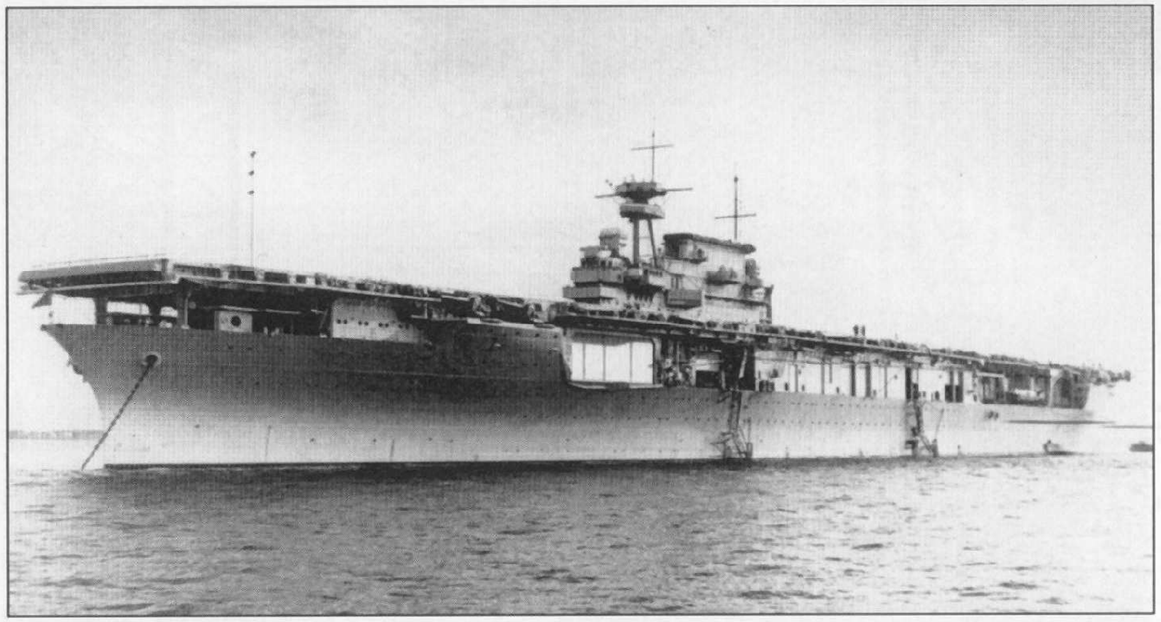
To translate this into altitude at any particular elevation of the gun required gunnery tables (or a lot of experience and a good memory on the part of the gun captain). When the preset time expired, the nose fuse exploded the bursting charge, which created a more-or-less spherical space filled with shell fragments and explosive gases that would be fatal to any aircraft within a few yards of the detonation and dangerous for some distance beyond that. The process of firing this gun on *Yorktown* involved carrying the shell from a hoist located against the rear bulkhead of the gun sponson to the fuse setter located on the gun mount, then to the breech. This would be followed by a powder charge in a brass cartridge sealed with a cork plug. A loaded cartridge case weighed approximately 28.7 pounds, depending on the type of powder. An empty cartridge weighed 13.25 pounds. The gun captain, connected by earphone to one of the Mk 33 directors, had only a few seconds to pass instructions to the loader (who would set the nose fuse), layer, and trainer to get the gun loaded and pointed in the right direction. (The layer controlled the pointing of the gun in the vertical axis; the trainer pointed the gun in the horizontal axis. For all guns larger than a .50-caliber or 20 mm, this was done by turning hand wheels that controlled separate gear trains. The director attempted to predict what angles and fuse timing would put a shell on target some number of seconds in the future.)

It's a testament to the skill of the gun crews that any success was achieved at all. (The success rate with this gun improved dramatically with the introduction of the variable time [VT]/proximity fuse in 1943,

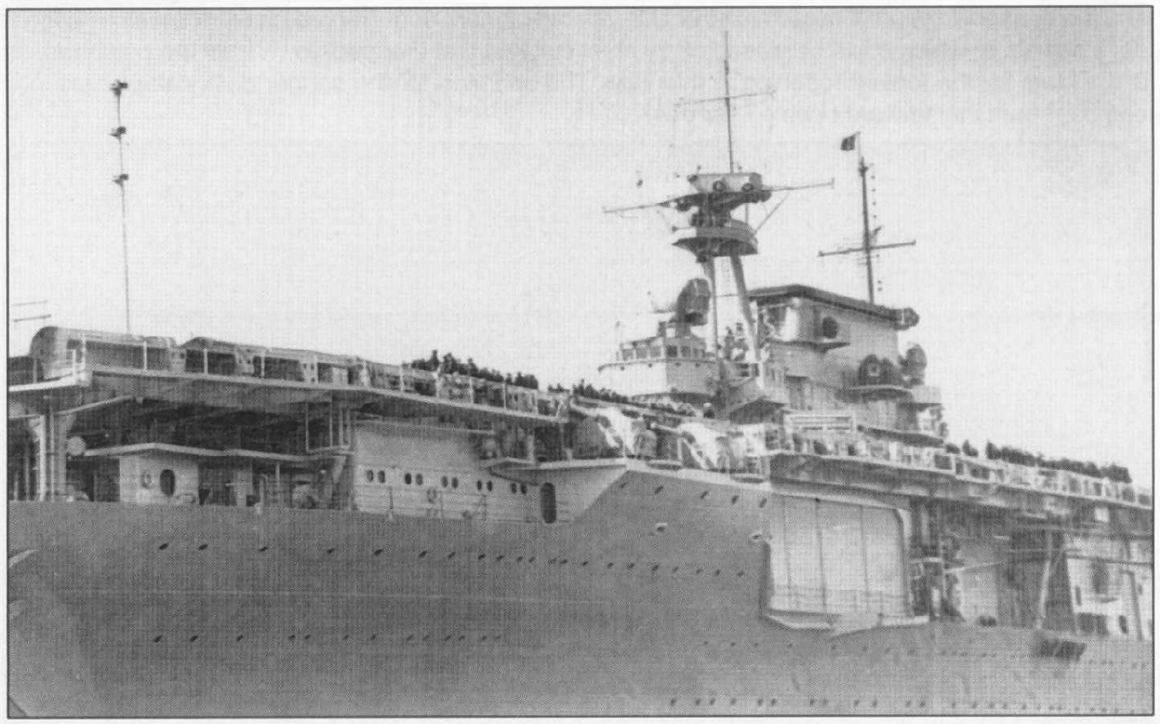
Yorktown is launched from the building slip at Newport News Shipbuilding, 4 April 1936. Her fine lines and relatively narrow beam would cause her and her sisters stability problems throughout their careers. *(NARA)*

A month after her commissioning at Hampton Roads, Virginia, 30 October 1937, *Yorktown* is painted in the standard peacetime scheme, overall Haze Gray. All of her boats are in the water, tied up at booms extending from her side. Before she left port, they would be hoisted into the space alongside her island and the boat pockets aft. Characteristic of U.S. aircraft carriers from *Ranger* on were the large hangar deck openings, which could be closed off by steel curtains that dropped down from the overhead, as is the case for the forward opening in this view. The sponson for the hangar deck catapult extends outboard from that forward opening. *(NARA)*





Two views of *Yorktown*'s port side on the same day as the last view. Two more boat booms and a pair of accommodation ladders up the side of the hull indicate that the crew was probably allowed liberty that day. The view below was taken from much closer than the one above and gives somewhat better detail of her island structure. Immediately aft of her navigation bridge is the boxy Primary Flight Control (Pri-Fly), where the "air boss" controlled all movement of aircraft on the flight deck. Just aft and below that is a large triangular structure projecting out over the flight deck. This was used to display messages to flight and flight deck crews. A flight deck was a busy and noisy place, and communication with crews on deck was often difficult, even with multiple large loudspeakers, such as the pair on the forward face of the fighting top below. The display boards must have been difficult to maintain, because by 1939 they had been removed. The athwartships catapult sponson extended out past the hull on this side as well. *(NHC)*



which made the fuse-setting step unnecessary, but that didn't remove from the gun crews the necessity to aim the gun correctly.)

The most numerous AA weapon on *Yorktown* was the Browning M2 water-cooled .50-caliber (0.5 inch) machine gun. *Yorktown* carried 24 of these in single pintle (pivoting pin or bolt) mounts. Sixteen of them were located four each in four galleries around the edge of the flight deck, and the remaining eight were in the superstructure (four in the fighting top and a pair both before and aft of the funnel). This was a reliable weapon with a high rate of fire, but with the obvious disadvantage of requiring a direct hit to have any effect and a round of such light weight, 1.71 ounces, that even a direct hit would rarely bring down an attacking aircraft of 1940s vintage.

This problem was well understood by the U.S. Navy. As early as October 1928, the Navy urged development of a heavier AA machine gun. The 1.1-inch machine gun was ready for testing in 1931 and was rushed into production in 1934, even though all the known problems hadn't been worked out. The standard mount was a four-barrel, water-cooled arrangement that allowed a mount to approach the .50-caliber machine gun's maximum burst rate of 500 rpm. The 14.7-ounce round had a fuse and a bursting charge of 0.59 ounces. Theoretically, a single hit would be enough to destroy an attacking aircraft.

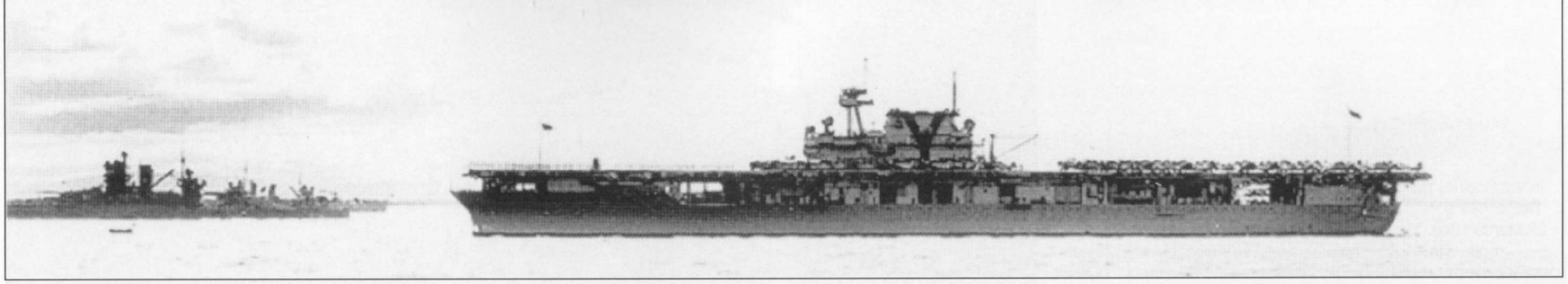
Sometime, probably early in 1940, *Yorktown* was fitted with four quadruple Mk 2 mounts, two each fore and aft of the island. The Mk 2 mount differed from the original version in having a stiffer gun mount and deleting a slewing feature that allowed the barrels to be pivoted from side to side without training the mount. This was an idea that sounded good in theory, but proved impossible to use in practice. In its place, the Mk 2 mountings were designed to accept Remote Power Control (RPC), which used small electric motors to aim the mount under the control of a director.

In *Yorktown*, the control of the four 1.1-inch mounts was to be provided by a pair of Mk 44 directors. This was simply a ring sight and a spotting telescope, similar to that found on the gun mount, but physically removed from the gun to reduce the smoke and vibration. (Most notably, the Mk 44 director lacked any lead computing capability.) RPC, when engaged, caused the mount to automatically follow the movements of the director and fire when the director's firing key was closed. The local gun crew was then responsible only to keep the gun loaded, though the mounts still had gun captains, trainers, and layers in case remote control was lost due to damage or breakdown, an all too frequent occurrence in the early days of this technology. It is not known whether *Yorktown* actually had either the planned Mk 44 directors or the RPC gear fitted to her 1.1-inch mounts during her brief combat career. (It is known that *Lexington*, lost at the Battle of the Coral Sea, carried 11 1.1-inch mounts, which had neither directors nor RPC, even though both were planned.) The 1.1-inch gun was never popular with the fleet, because no amount of training and maintenance could make it reliable; it was prone to frequent jamming, which could take a mount out of action at a critical time.

Modified Bridge

Yorktown's bridge structure was modified around this time, probably at the same time the 1.1-inch mounts were added. She had been built with a large, square-faced, open flag bridge midway up the front of her island, with a smaller navigation bridge above it, cut back at the corners and topped by a pilothouse with multiple windows. To make room for the forward superfiring 1.1-inch mount (number 2 mount), most of the open flag bridge was deleted; the only part that remained was on the outboard side of the island. The forward face of the navigation bridge was enlarged, squared off, and given an elaborate wind deflector on its forward face.

In July-August 1940, *Yorktown* received her first radar, a CXAM (U.S. Navy's prototype) air-search set. The CXAM's antenna was a 17-foot-by-18-foot mattress in a heavy frame that allowed it to pivot horizontally, providing a primitive form of height-finding. (Later forms of height-finding radars, such as the SM and SP, had a similar "nodding" feature, but with a much narrower beam were more effective.) The large CXAM antenna was placed on the fighting top, displacing the four .50-caliber machine guns previously located there. (The displaced machine guns were added to the four deck-edge galleries, which



Yorktown's sister *Enterprise* (CV 6) joined the fleet within a year, and soon pilots off these two ships experienced the same problems as those flying off the *Lexingtons*. The two sisters were so similar that pilots sometimes landed on the wrong carrier, much to the amusement of the deck crews. Similar measures were taken, including painting an abbreviation of the carriers' names across the ends of the flight decks and painting a big, black "Y" on *Yorktown*'s funnel. She is seen here as she appeared during Fleet Problem XX at Gonaives, Haiti, February 1939. *(NARA)*

each now comprised five rather than four guns.) This was an excellent radar, capable of detecting a single aircraft at 50 nautical miles and large surface ships at better than 15 nautical miles.

In August 1941, the Navy acknowledged that the AA suite on its larger ships was inadequate and announced the intention to replace the light and medium components with 20 mm and 40 mm batteries, respectively. The plan was to fit the *Yorktowns* with 24 20 mm single mounts, replacing the .50-caliber battery on a one-for-one basis, and six 40 mm twin mounts, replacing the four existing 1.1-inch mounts and adding two at the bow under the relatively short flight deck overhang. (The longer overhang aft prevented a similar placement at the stern.) This was the plan, but in practice, the 40 mm Bofors mounts were slow to materialize, and the limited number of 20 mm Oerlikons that became available replaced some but not all of the existing .50-caliber batteries.

Sources differ considerably about how many 20 mm mounts were placed on *Yorktown* or exactly when the work was done, but at the Battle of the Coral Sea in May 1942, she had a pair at the bow (where two of the 40 mm mounts were intended to go) and 10 single mounts along the portside edge of the flight deck, five mounts replacing the same number of existing .50-caliber emplacements fore and aft. The existing boat storage outside the island was removed, as was the boat crane, and a gallery of five more 20 mm mounts was installed. (It is really only possible that this work was done at Norfolk before she departed for the Pacific in December 1941 or at Pearl Harbor during her two-week visit at the beginning of February 1942. It is most likely that it was at the latter time. Photographic evidence shows clearly that the 10 existing .50-caliber machine guns on the starboard side were not replaced.)

At the same time that 20 mm mounts were added, splinter shielding was added at all of her AA mounts and also on the pilothouse roof. The now superfluous small rangefinder on the pilothouse roof was deleted at this time. It was probably at Norfolk that she received the wartime Measure (Ms) 12 graded camouflage scheme that she carried for the rest of her career.

The 20 mm/70 Oerlikon was a vast improvement over the .50-caliber machine gun it was intended to replace. (The British adopted this Swiss-designed gun in 1939, and it was being made in limited quantities in the United States for the British before the U.S. Navy first tested the weapon in June 1941. The decision to adopt this gun was easy, and production ramped up rapidly once the United States entered the war.) With a rate of fire not much lower than the smaller gun's (a maximum cyclic rate of 450 rpm), the Oerlikon fired a high explosive (HE) round that weighed 4.34 ounces with a 0.38-ounce bursting charge. A 60-round drum magazine made them easy to load. This was a popular weapon, being extremely reliable and having far greater stopping power than the .50-caliber. Only late in the war, when kamikazes appeared that needed to be not just disabled, but literally blown apart, did the gun lose favor to the harder-hitting 40 mm Bofors.

Plans were made to replace the 1.1-inch mounts around the island with twin 40 mm mounts and to add FD (Mk 4) fire control radars to her Mk 33 fire control directors at *Yorktown*'s next yard visit, but this visit at the end of May 1942 turned out to be far too short to do much more than repair the damage she received at Coral Sea. She still lacked these useful additions when she left for Midway on 30 May after only three days in port. One change that appears to have been made in this last brief yard visit was the addition of degaussing cables around her hull. (It is possible that these had been added earlier, during her February yard visit, but the author has seen no photographic evidence that shows these cables before May, and the photograph on page 14 clearly shows the cables being worked on.)

Operational History

Yorktown's shakedown started in the Caribbean in January 1938. The full integration of her air group didn't start until she resumed training at the end of her post-shakedown yard availability in October. *Yorktown* spent the rest of 1938 and early 1939 operating off the East Coast of the United States as flagship of Carrier Division 2, along with her close sister *Enterprise*. Both carriers transferred to the Pacific Fleet (also known as the Battle Fleet) in April, sailing for their new home port, San Diego, California. Two years later, in April 1941, *Yorktown* was transferred back to the Atlantic. As dangerous as the Japanese appeared to be, the very real danger of a British collapse in the face of the Nazi U-boat offensive forced the United States to reinforce the Atlantic Fleet at the expense of the Pacific. *Yorktown* spent most of the rest of 1941 patrolling the Atlantic coast conducting search patrols, and she even made a few forays as far afield as Newfoundland and Bermuda. This included some convoy escort duty that put her in direct peril from U-boats.

All this was brought to an end by the attack on Pearl Harbor. With the battle line disabled, the U.S. Navy was left with just three operational aircraft carriers in the Pacific to oppose the seemingly invincible Japanese fleet. The torpedoing of *Saratoga* on 11 January 1942 further reduced credible American strength in the Pacific to just *Lexington* and *Enterprise*. *Yorktown* was needed desperately in the Pacific. *Ranger*, *Wasp*, and the newly commissioned *Hornet* would remain in the Atlantic for the moment.

Yorktown departed Norfolk on 16 December 1941 and transited the Panama Canal. Reaching San Diego on 30 December, she formed the core of Rear Adm. Frank Jack Fletcher's Task Force (TF) 17. Her first duty was to escort a convoy of transports carrying a Marine garrison to Samoa. She departed Samoa on 25 January 1942 in company with *Enterprise* on the first of the "reprisal raids" intended mainly to distract the Japanese Navy and perhaps slow their headlong rush through the South and Central Pacific. The two carriers split soon after leaving Samoa; *Yorktown* attacked Japanese positions in the Gilberts (now the Republic of Kiribati), while *Enterprise* hit the Marshalls. TF 17 put into Pearl Harbor only to leave again on 14 February, headed for Australian waters. There she rendezvoused with TF 11 based on *Lexington* and headed to attack Rabaul to cover the U.S. landings at Nouméa. News of Japanese advances in eastern New Guinea (now Papua New Guinea) caused the target of this raid to be changed to the ports of Lae and Salamaua on the north coast of that island, which were hit on 10 March 1942. Aircraft from the U.S. carriers flew over the Owen Stanley Range, attacked Japanese shipping and installations, and returned to the carriers in the Gulf of Papua, losing only one aircraft in the process.

The two U.S. task forces remained in the Coral Sea area for the next three months. *Yorktown* made only one brief replenishment stop at Tonga in mid-April; otherwise, she remained at sea in anticipation of the next Japanese move against the sea lanes between the United States and Australia. That move came

In the Pacific, *Yorktown* loads her air group at North Island, San Diego, using the large aircraft crane at the aft end of her island, 29 March 1940. She now has four recently added quad 1.1-inch mounts fore and aft of her island. Her flight deck is stained reddish-brown with chrome yellow stripes and the letters "YKTN" fore and aft. She has retained the black "Y" on her funnel. The triangular message board inboard of her island is now gone. *(NARA)*

at the beginning of May. The Japanese landed troops and engineers on Tulagi in the Solomons chain on 3 May and began setting up a seaplane base. In company again with *Lexington*'s TF 11, *Yorktown* headed north, attacking the new Japanese base the next day. Word that Japanese troop transports were headed toward Port Moresby on the southern shore of New Guinea drew the Americans farther north and into contact with the Japanese covering force, based on three aircraft carriers (the Pearl Harbor veterans *Shokaku* and *Zuikaku* and the smaller *Shoho*). The resulting two-day Battle of the Coral Sea (7 and 8 May 1942) was historic as it was the first major engagement in which the major combatants never came within sight of each other. All the attacks were carried out by carrier aircraft, which proved their potency by the damage each side inflicted on the other. The Japanese lost *Shoho* and suffered serious damage to *Shokaku*. More seriously, from the Japanese point of view, their air groups were decimated in the battle. *Shokaku* would be out of action for four months; even though undamaged, *Zuikaku* wouldn't be ready for combat any sooner.

The Americans lost *Lexington* to a massive avgas (aviation gasoline) explosion. *Yorktown* got off relatively lightly, avoiding all eight torpedoes aimed at her; she was hit by only one bomb and near-missed by two more. The one hit penetrated five decks before exploding in a storeroom on the fourth deck, the armored deck over the ship's engineering spaces. The bomb penetrated the flight deck near the aft end of the island and just starboard of the ship's centerline. The hole in the flight deck was small and quickly repaired. Fires below deck were also rapidly extinguished. Damage to boiler room uptakes caused three of the firerooms to be evacuated briefly when they filled with smoke. One of the near-misses was in fact more serious, causing a tear in the shell plating portside amidships and a persistent oil leak. None of the damage was serious or hindered flight operations, but *Yorktown* was ordered back to Pearl Harbor for repairs. Although the initial estimate was that she would require three months of yard work, she was given three days to complete repairs and replenish the ship.

Arriving at Pearl Harbor on 27 May, she was at sea again on the 30th, headed for the waters to the northeast of Midway Island, where she would rendezvous with TF 16, based on *Enterprise* and *Hornet*, on 2 June. The three carriers were waiting for a massive Japanese invasion fleet known to be approaching from the northwest. The decisive battle fought two days later is well-known and will not be described in detail here. The Americans devastated three of the Japanese aircraft carriers in morning strikes, but the fourth, *Hiryu*, survived long enough to launch two strikes at the Americans. The first strike was composed of 18 dive bombers, Aichi D3A1 Val Type 99 Carrier Bombers, launched at 1055. Seven of them got through *Yorktown*'s Combat Air Patrol (CAP), and three of those managed to put bombs on her flight deck.

The first exploded on contact with the flight deck just aft of the midships elevator. The explosion punched a 12-foot hole in the flight deck and caused severe casualties among the nearby gun crews, particularly among the crews of the 1.1-inch mounts at the aft end of the island. Fires were started in the hangar deck but were quickly extinguished by sprinklers and water curtains.

The second bomb pierced the flight deck 10 feet inboard of the island and exploded above the third deck in the boiler room uptakes, disabling two fire rooms and extinguishing the fires in three others. The explosion started a fire in the uptakes, which caused a vast plume of dense black smoke, but the fire wasn't serious and was extinguished in a half-hour. The situation in the firerooms was of much greater concern. With five of nine boilers off-line, speed immediately dropped to 6 knots, and after half an hour the ship drifted to a stop. (The four other boilers remained lit and were able to keep the generators running, supplying the electric power necessary to fight the fires and keep lights on in the ship.)

The third bomb pierced the forward elevator and exploded in a storage space on the third deck. The 14-foot hole in the elevator platform was quickly patched, but a fire in rag storage on the third deck proved impossible to completely put out.

At 1340, an hour and a quarter after the initial attack, three more boilers were brought on-line and *Yorktown* got under way again. She was soon making 20 knots and resumed flight operations. In the meanwhile, *Hiryu* had launched a second strike at 1330 consisting of only 10 Nakajima B5N2 Type 97 carrier attack aircraft, known as Kates. This attack was detected by *Yorktown*'s radar at 1355 and met by her CAP shortly afterward. The defense was less successful this time. Nine of the 10 Kates reached *Yorktown*, and seven launched their torpedoes. Two of those hit her portside amidships within a minute of each other. She lost all power as her boiler rooms flooded, and she drifted to a stop again, this time with a list that soon reached 26 degrees. At this point, assuming *Yorktown* was only minutes from capsizing, Capt. Elliot Buckmaster ordered the ship abandoned.

That should have ended the story, but *Yorktown* proved a tougher ship than anyone could have imagined. As night fell the ship was still afloat, and as TF 17 withdrew to the south to refuel, the destroyer *Hughes* (DD 410) was left to witness the proud ship's end. At noon the next day, 5 June, *Yorktown*

Yorktown's fantail is shown in June 1940, also at North Island. The aircraft with folded wings are TBD Devastator torpedo bombers; the aircraft at the top left are Northrup BT-1s, which didn't have folding wings. Two of her eight 5-inch guns are visible below the flight deck. The three light standards at the far side of her flight deck are actually on the dock and are not part of the ship. The flagpole in the middle of her flight deck would obviously be removed for flight operations. *(NHC)*

incredibly was still afloat and upright. Her list in fact appeared not to have increased past 26 degrees. Joined by the small tug *Vireo*, a tow was rigged and the two ships, still accompanied by *Hughes*, started south at 2 knots. A small salvage party was put aboard to jettison loose gear from the flight deck, but was taken off again at dusk.

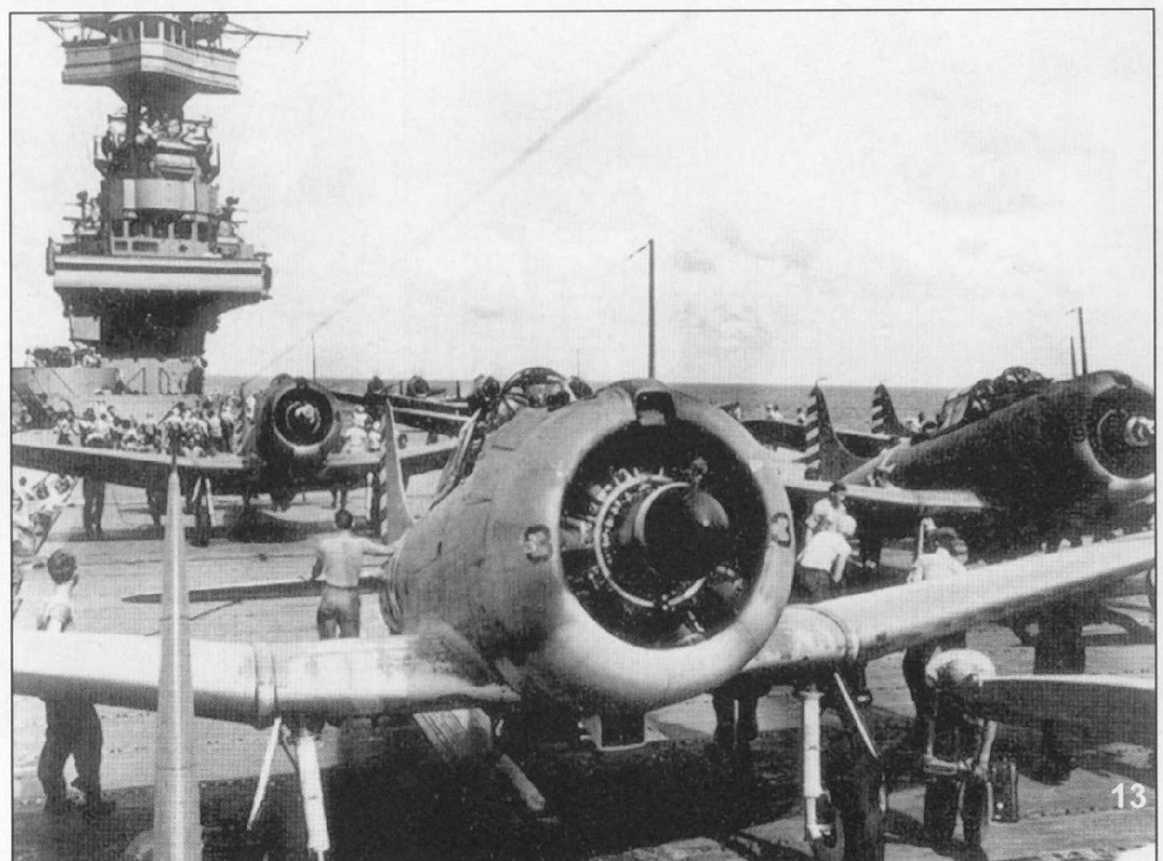
The next morning, 6 June, Buckmaster, with five additional destroyers, arrived back on the scene and took charge of what became a serious effort to save the stubborn ship. A party of 29 officers and 141 enlisted men went aboard with cutting torches and portable pumps. The destroyer *Hammann* (DD 412) came alongside to provide electric power. By early afternoon, one of the portside 5-inch guns had been cut loose and pushed over the side, and a second was about join it. A pair of disabled F4F Wildcats, which had been lashed to the deck on either side of the patch in the flight deck aft of the island, were also jettisoned. That and the pumping had managed to reduce *Yorktown*'s list by 2 degrees.

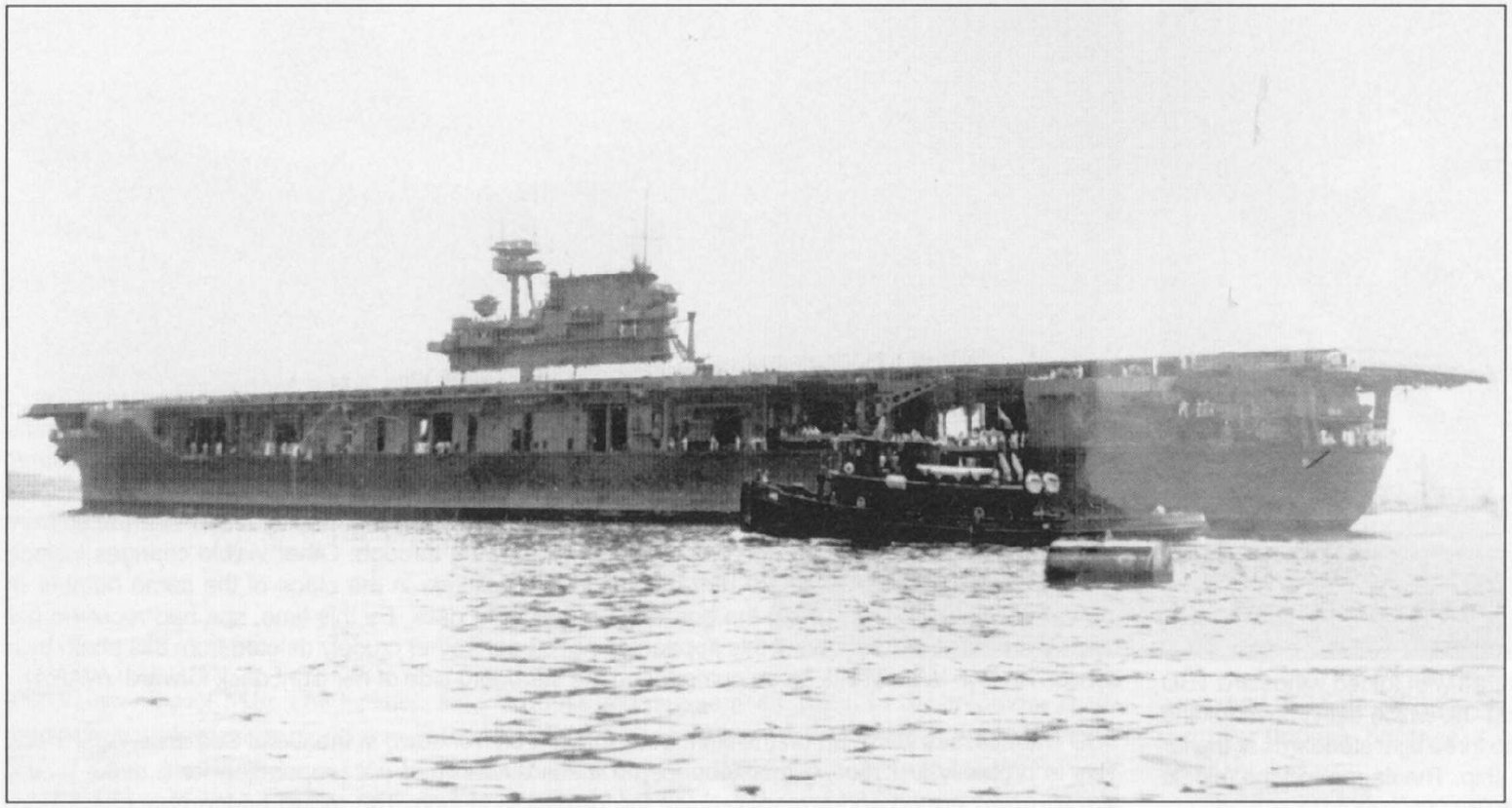
Sadly, this effort was in vain. At 1336, lookouts on *Hammann* sighted four torpedoes heading for the carrier. Despite five patrolling destroyers, the Japanese submarine *I-168*, under Sho-sa (Lt. Cmdr.) Tanabe Yahachi, had made a nine-hour submerged approach to within 1,900 yards, where she fired four large Type 95 torpedoes at *Yorktown*'s exposed starboard side. The first torpedo hit *Hammann*, causing her to break in half and sink within minutes. The second and third hit the carrier near the after end of her island. The fourth torpedo missed aft. To make matters worse, a massive underwater explosion, probably *Hammann*'s depth charges going off, seemed to bodily lift the carrier and drop her back down again.

Amazingly, *Yorktown* still didn't sink. In fact, the counterflooding on the starboard side caused by the two torpedoes reduced her list to 17 degrees. Nevertheless, with a submarine loose in the vicinity, Buckmaster couldn't leave the salvage crew on board, and they were removed. As the sun went down that night, *Yorktown* appeared stable and plans were made to put the salvage party back aboard in the morning, but this time she'd had enough. Starting around 0530 on 7 June, her list began to increase noticeably, and at 0700 she rolled over on her port side and slid quickly beneath the waves.

The war has begun, and *Yorktown* shows some of the changes that were made in the early months of 1942. She now wears camouflage, the Ms 12 graded system — Sea Blue (5-S) up to the level of the hangar deck and the not-much-lighter Ocean Gray (5-O) above that — and her flight deck is stained Deck Blue (20-B), a color very similar to Navy Blue (5-N) that rapidly faded to a transparent medium blue with the color of the pale wood deck showing through. Other visible changes include the emplacement of 10 single 20 mm mounts in two galleries in the place of the same number of .50-caliber machine guns along the port edge of her flight deck. By this time, she had received her CXAM radar on her foretop, but this appears to have been rather crudely deleted from this photo by a censor. An F4F Wildcat sits on an outrigger on the starboard side of her flight deck forward. *(NARA)*

SBD Dauntlesses warm up on the flight deck forward on *Yorktown* in the Coral Sea area, April 1942. This is probably just routine maintenance on these aircraft and not preparation for a strike — the aircraft aren't armed and are spotted too far forward to launch. The rebuilt bridge now has a long, elaborate wind deflector across its broad front. The small main battery rangefinder on the pilothouse roof has been removed and the resulting open space protected by tall splinter shielding. There were plans to add FD radars to Yorktown's Mk 33 directors, but the opportunity never arose before her loss at Midway. *(NARA)*

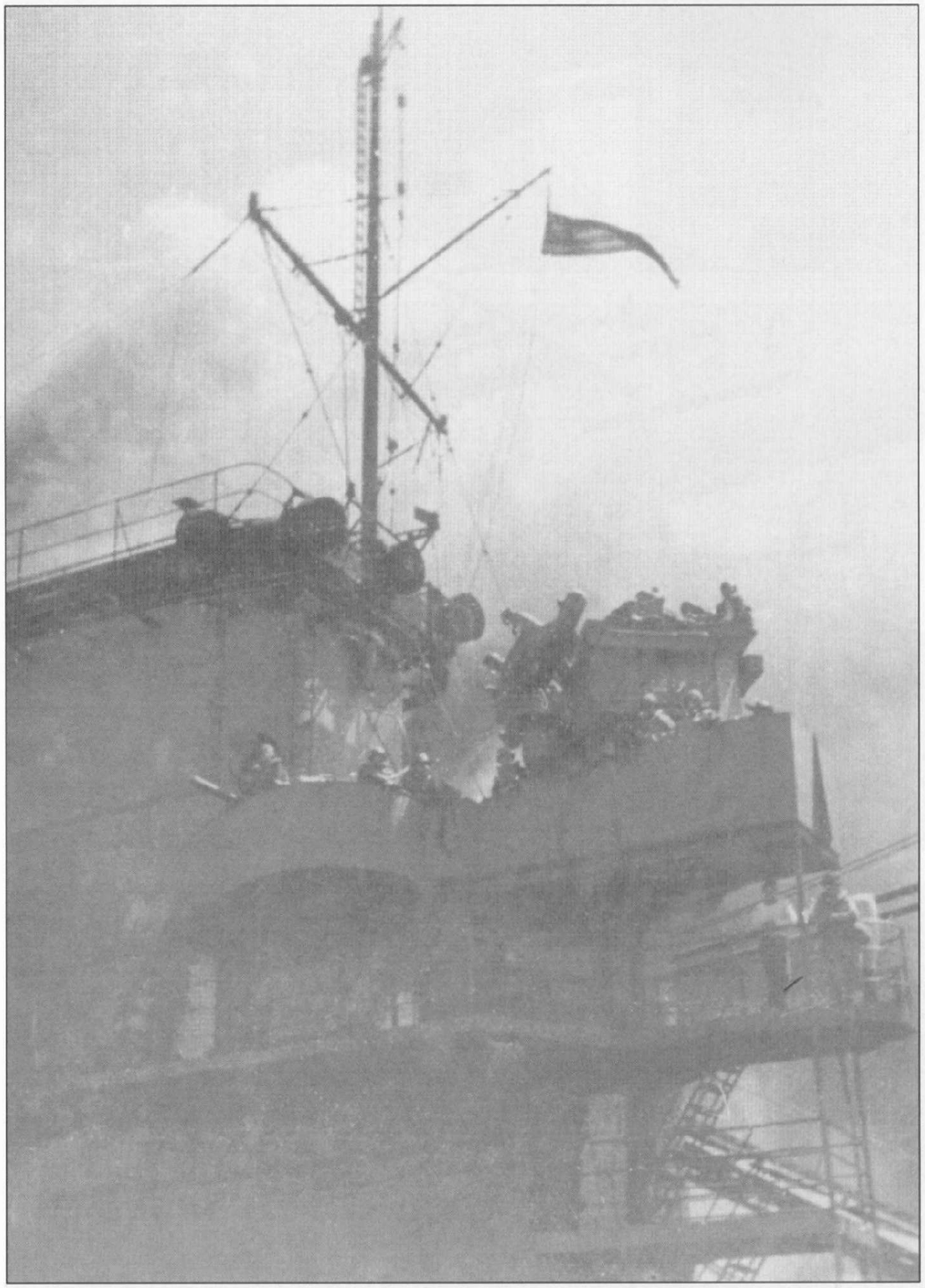


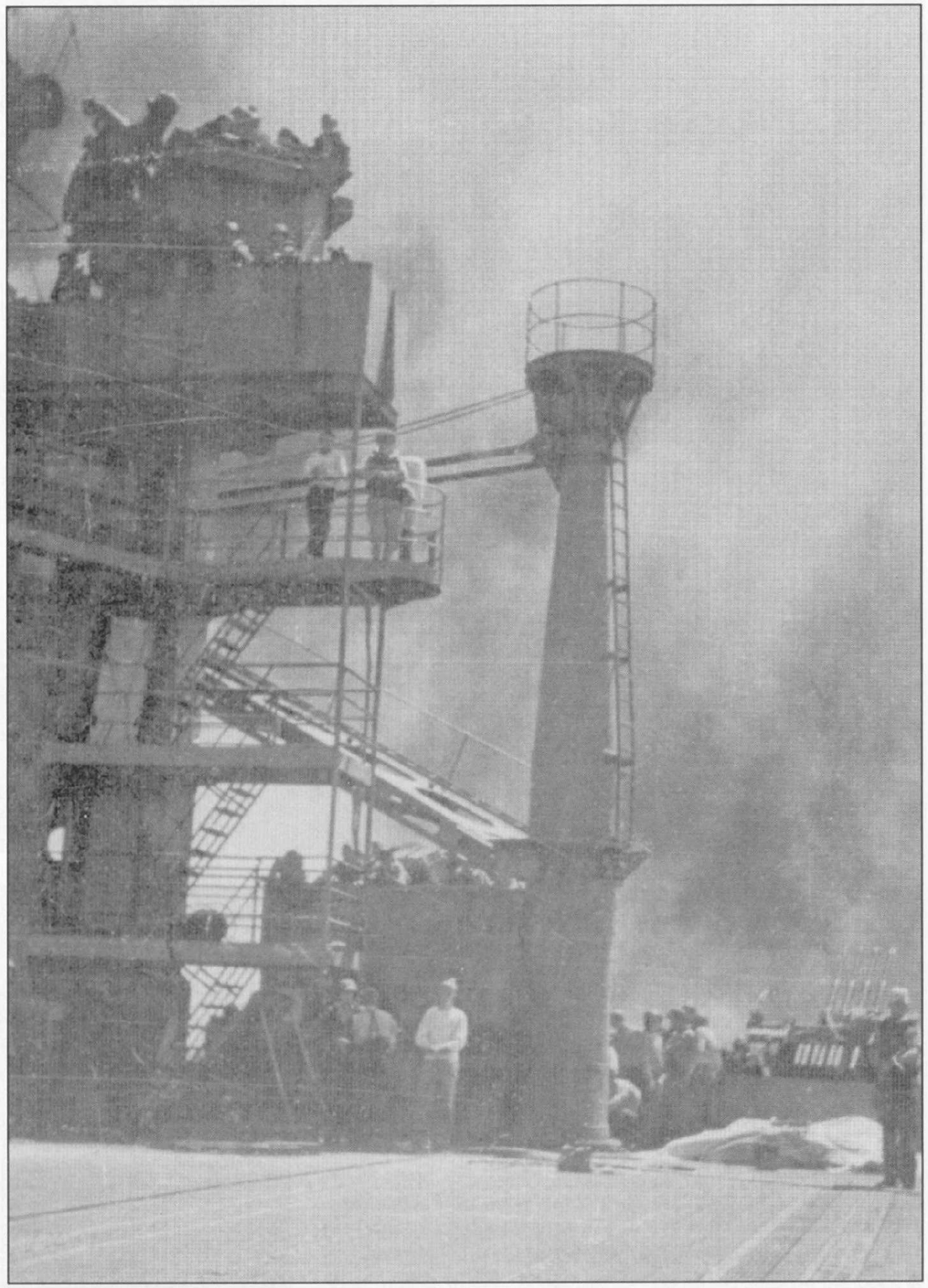


(Left) The off-duty crew, dressed in whites, lines the edge of the flight deck on *Yorktown* as she enters Pearl Harbor after the Battle of the Coral Sea, 27 May 1942. This wasn't a formal "dressing of the ship," just a bunch of sailors curious to see the damage done to the harbor and eager for a few days of liberty. *Yorktown* was given only three days in port, and that time was spent repairing and replenishing the ship as she prepared for yet another major battle. The framework around the CXAM antenna can be seen on her foretop. *(NHC)*

(Bottom left) Yorktown was dry-docked for two of the three days she spent at Pearl Harbor at the end of May 1942. The damage she had received at Coral Sea wasn't major, but a near-miss had opened a seam below the waterline on her port side, and this had to be repaired. This view clearly shows the pair of 20 mm mounts added at her bow. Workmen on temporary scaffolding are working on the degaussing cables at her bow. The Ms 12 camouflage had Sea Blue up to the level of her hangar deck and the very similar Ocean Gray above that. Her CXAM antenna on her foretop is end-on, allowing the breadth of the lower frame to be seen. *(NASM)*

(Bottom right) A PBY Catalina (flying boat) flies past *Yorktown* as she prepares to launch her morning strike at the Japanese at Midway, 4 June 1942. Most of the "full deck" launch is in place, the order of the aircraft determined by the amount of flight deck each type required to get airborne. TBDs are spotted farthest aft, SBDs forward of them, and F4Fs closest to the bow. *(NARA)*

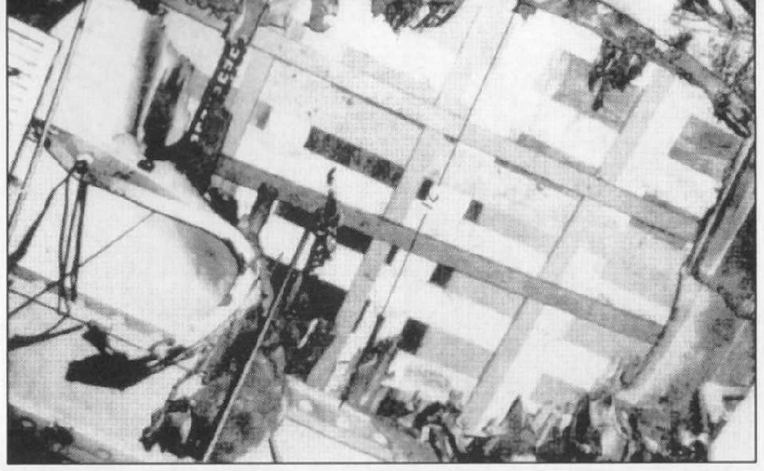




(Above photos) Yorktown was hit by three bombs in the first Japanese counterattack at Midway, just before noon on 4 June 1942. These two views, taken within seconds of each other, show the aft end of her island, an area damaged by bomb fragments from the first bomb, which exploded on contact with her flight deck just aft of the midships elevator. A number of men manning the two aft 1.1-inch mounts were killed, some of the bodies covered by the white tarp in front of number 4 mount. *(NARA)*

(Above) The second bomb started a fierce fire in *Yorktown*'s boiler uptakes, causing her to lose way and generating the massive plume of dense black smoke seen in this shot taken from the starboard forward AA battery, 4 June 1942. Bearing and elevation for the two 5-inch/38 mounts could be provided by the Mk 33 director, but, in the heat of action, these guns were generally fought under local control. Either way, the guns were manually aimed from the layer's and aimer's positions on either side of the barrel, through the open sights. A pair of outriggers project from the flight deck aft of the guns. *Astoria* (CA 34) crosses in the background. *(NARA)*

(Right) A bearded CPO steps over a deflated fire hose at the forward edge of the midships elevator on *Yorktown*, 4 June 1942. This photo was probably taken a few minutes before the shots on the preceding page. At the right, a pair of corpsmen work on a wounded sailor. In the upper left, clips of ammunition for the number 3 1.1-inch mount can be seen lined up, ready for use. The strips of alternating "U"-shaped slots in the flight deck are for tying down aircraft. *(NARA)*



(Clockwise from upper left)
One argument the U.S. Navy used against the armored flight decks favored by the British was the relative ease with which American flight decks, made from thick planks of pine backed by 4-pound, 0.1-inch mild steel plate, could be repaired after battle damage. The repair crew works on the 12-foot hole punched in *Yorktown*'s flight deck aft of the island by the first bomb, 4 June 1942. The process involved chopping out damaged planks and laying on new planks over the hole; repair of the steel deck under the wood would be left for a shipyard. *(NASM)*

The patch to *Yorktown*'s flight deck aft of the island is shown from the hangar deck. A crossing pattern of beams and planks was then topped by sheets of plywood. This probably wouldn't have been strong enough to support a loaded aircraft. Fortunately, the hole was well to the starboard side of the flight deck, and two disabled Wildcats were lashed to the deck fore and aft of the patch to prevent aircraft from being placed directly on it. *(via cv6.org)*

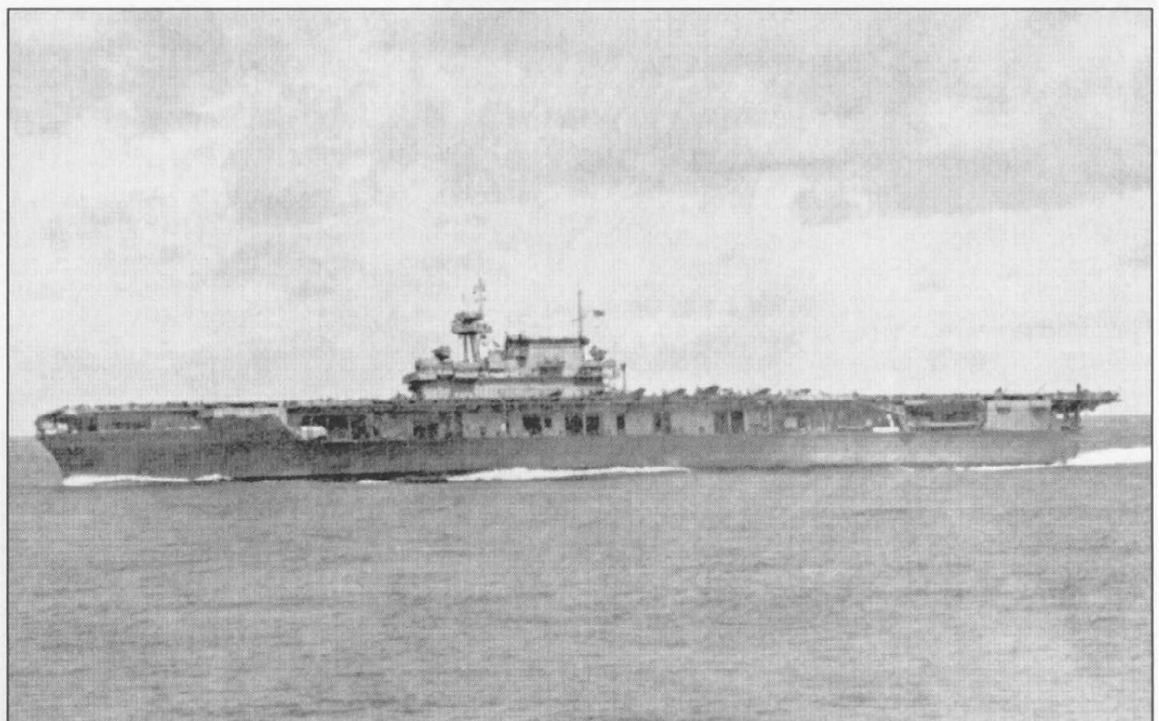
Fighting fires in the confined space of a hangar deck is a dangerous and difficult business, but crews on *Yorktown* had some advantages over their counterparts on the Japanese aircraft carriers in the battle that day. Only a few aircraft remained in *Yorktown*'s hangar when the bombs hit, and those were like the Devastator triced up in the overhead, not a hangar full of fueled and armed aircraft. Also, *Yorktown*'s hangar had the large openings seen here, which would have allowed any burning aircraft or munitions to be rapidly dumped over the side. *(NARA)*

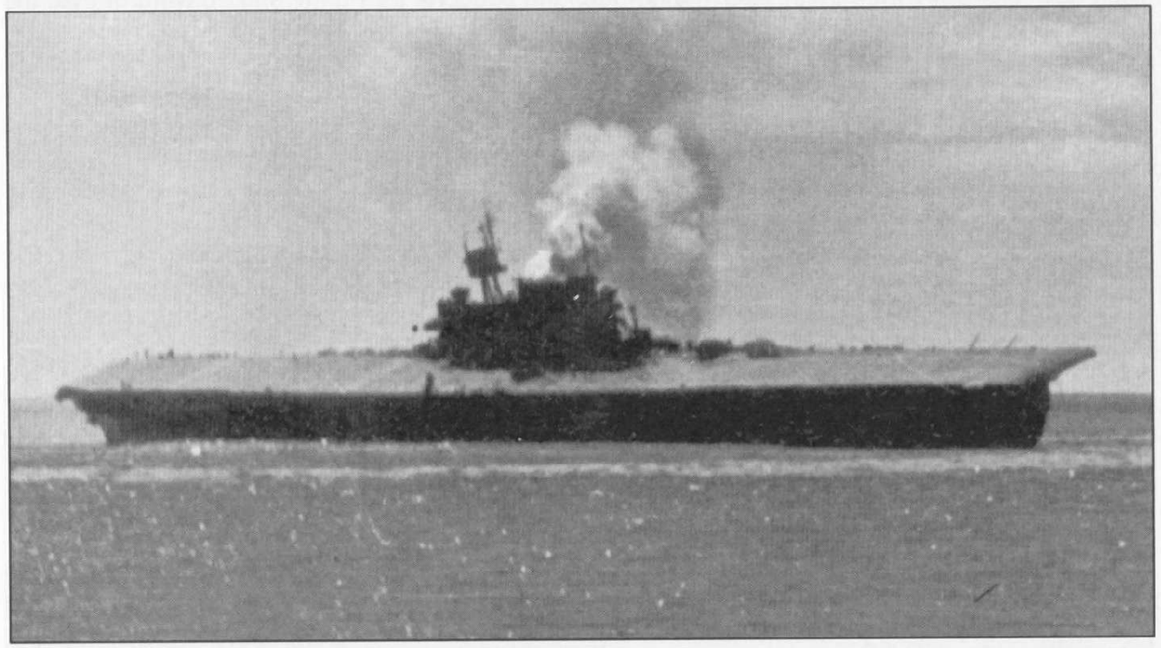
Thick black smoke billows from *Yorktown*'s funnel due to the fire in her boiler uptakes, while a crewman works on the hole in her forward elevator caused by the third bomb to hit her that day. Thin smoke from the fire in rag storage on the third deck comes up around the edge of the elevator. The large frame of her CXAM antenna can be seen atop her foretop, with the antenna for a YE homing beacon at the top of her foremast. Most of the forward anti-aircraft battery on the starboard side can be seen: two 5-inch/38 mounts, at least three of the .50-caliber machine guns, and numbers 1 and 2 1.1-inch quad mounts in front of the island. The raised slats on the deck in the foreground are the folded-down forward wind palisade. *(NARA)*

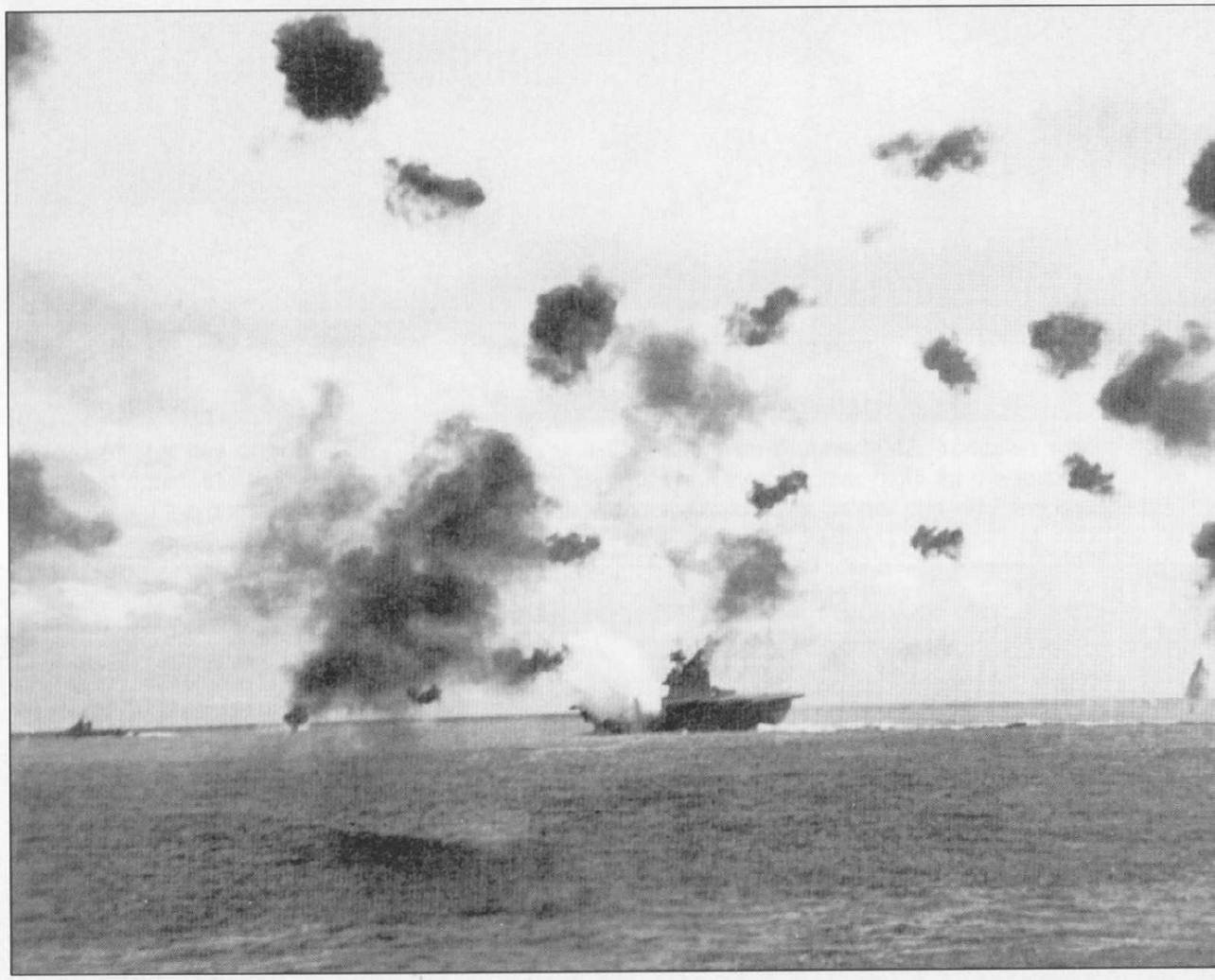
(Left) Yorktown, as seen from *Astoria*, after drifting to a stop, approximately a half-hour after the first Japanese attack, 4 June 1942. Dense smoke still pours from her funnel, caused by the fire in her boiler uptakes. Smoke is also rising from the flight deck, caused by the same fire. F4F Wildcats that were being prepared for takeoff when the dive bombers attacked have been parked at the bow to keep them out of the way of repair crews. At least two aircraft can be seen on her hangar deck aft. *(NARA)*

(Bottom left) Perhaps a half-hour later — it is now about 1300 — and *Yorktown* is dead in the water, the result of a second strike. The smoke from the funnel has gotten denser, but progress has been made, and plans are being set up to get under way again and to launch the on-deck Wildcats to form a CAP. The aircraft have therefore now been spotted aft. *(NARA)*

(Bottom right) An hour later — *Yorktown* is under way, and the fires have been brought under control. The CAP Wildcats have been respotted toward mid-deck and are now being warmed up preparatory for launch. *(NARA)*

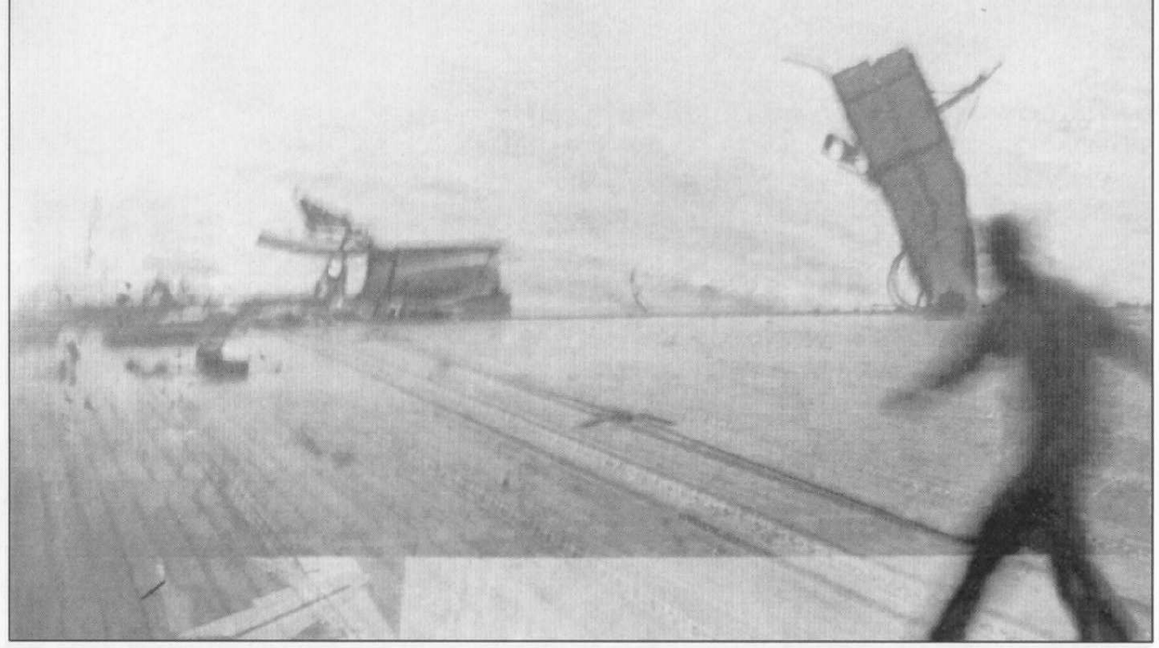






No sooner had the CAP launch been completed than a second Japanese attack was detected. This one was composed of 10 Kate torpedo bombers, nine of which got through the CAP. They pressed home their attack with determination and skill, managing to put two torpedoes in *Yorktown*'s port side. *(Top left)* Two Kates pass up the carrier's port side as she tries to twist away. The two Wildcats lashed to the deck on either side of the patch can be seen aft of her island. *(Top right)* The same two aircraft continue on, one flying low and straight, the other banking across *Yorktown*'s bow. *(Bottom right)* A few moments later, as *Yorktown* turns away from *Pensacola* (CA 24) — where the photographer is located — the second of two torpedoes explodes against her port side. *(NARA)*

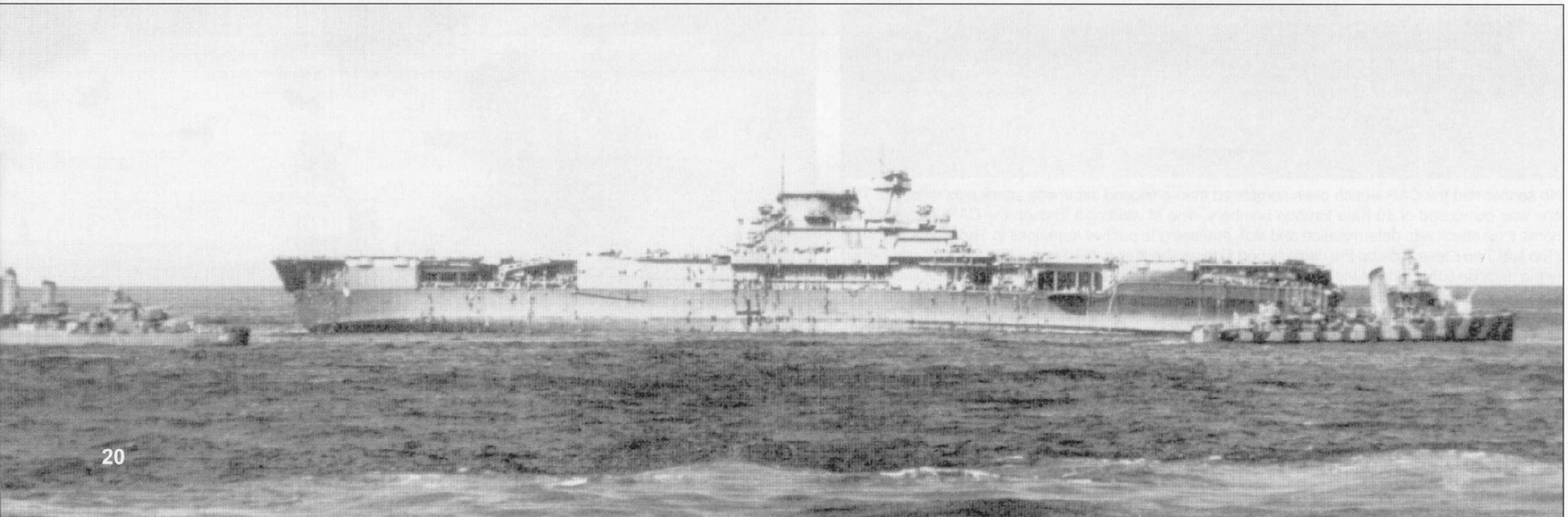
(Bottom left) Again dead in the water, *Yorktown* is now completely without power. The two torpedoes have flooded all nine contiguous fire rooms, causing the venting of steam seen here. The list to port soon increased to 26 degrees. *(NHC)*



(Clockwise from left)
With no power, there was little that *Yorktown*'s crew could do to control the damage. In this famous, water-damaged image, crewmen instinctively gather under the meager shelter of the island as the flight deck tilts away from them. Above them arch the supports for Pri-Fly and, forward of that, the underside of the flag bridge. *(NARA)*

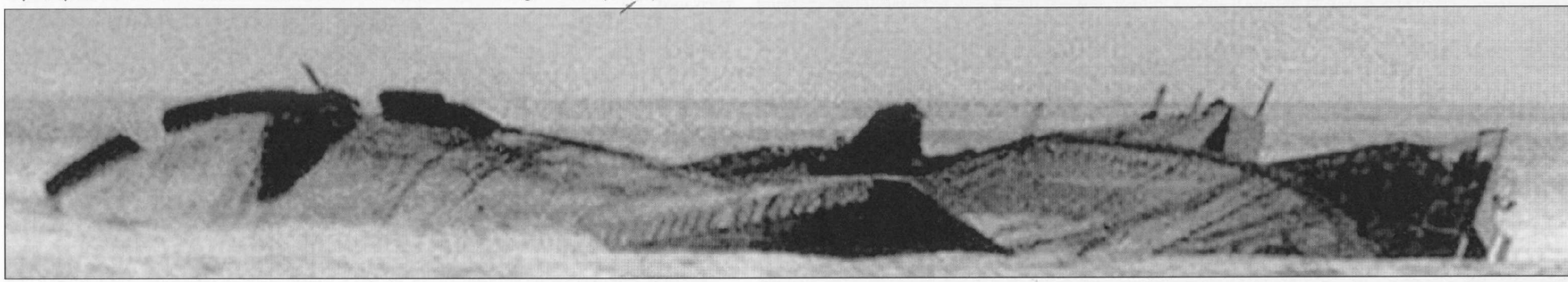
A crewman's blurred image passes in front of a portion of the portside gallery bent upward by the explosion of one of the two torpedoes. *(NARA)*

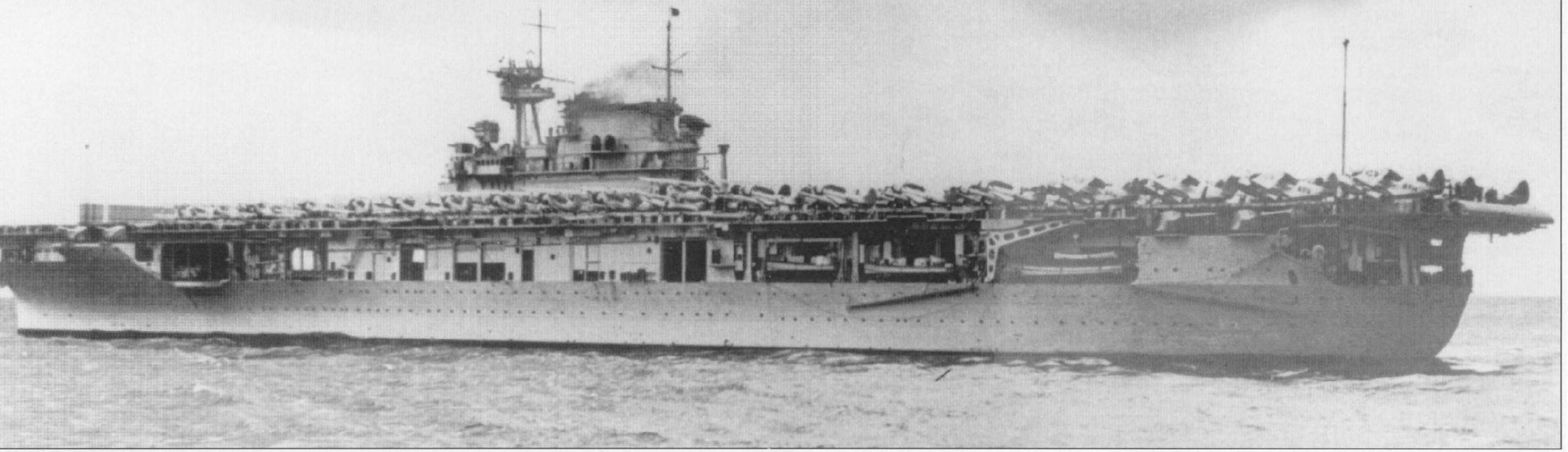
With the list increasing rapidly, *Yorktown*'s captain orders the ship abandoned at approximately 1700, 4 June 1942. The crew can be seen heading down ropes, mainly from the hangar deck openings. The cruiser *Astoria* and an unidentified destroyer, probably *Morris* (DD 417), stand by to pick up the crew. When the boat stowage outside the island was taken over by a gallery of 20 mm guns, the boat crane located there was removed. *(NARA)*



(Above) When *Yorktown* didn't sink immediately, TF 17 withdrew to refuel, leaving the destroyer *Hughes* (DD 410) to witness her demise. The next day she was still afloat, and two survivors who had spent the night on the supposedly abandoned carrier showed up on the flight deck. *Hughes* sent over a longboat to pick up the two crewmen, one of whom died of wounds soon after being rescued. *(NARA)*

(Below) After a day of heroic effort to stabilize the listing carrier on 6 June 1942, *Yorktown* was torpedoed again, this time by the submarine *I-168*. Even then, it took another night for the ship to finally give up the ghost. Soon after dawn on the 7th, *Yorktown* rolled over on her port side and slid under the waves. *(NHC)*





Seen near Pearl Harbor shortly after transferring to the Pacific Fleet, the still-new *Enterprise* (CV 6) carries a full deck-load of aircraft, 8 October 1939. In this view she would be difficult to distinguish from her sister *Yorktown* were it not for the lack of a funnel band, such as was carried at the time by the other large carriers in the U.S. Navy. The forward flight deck palisade is raised to protect the aircraft on deck from wind over the bow. The air group on her deck is definitely transitional, with three models of biplanes still in evidence. *(NHC)*

Enterprise (CV 6)

The seventh U.S. Navy ship to carry the name, *Enterprise* (CV 6) was laid down alongside *Yorktown* on 16 July 1934 at Newport News. She was launched on 3 October 1936 and commissioned into the Navy on 12 May 1938. After the normal working-up period, she was ordered into the Pacific, along with her sister, in April 1939, where she remained for the next six eventful years.

Externally, *Enterprise* was nearly identical to *Yorktown*. They were in fact so similar that pilots complained about being unable to tell them apart when attempting to land. Several visual clues were added to the ships to help distinguish them. *Enterprise* had a large "EN" painted in chrome yellow on her flight deck fore and aft soon after her commissioning. (*Yorktown* had the letters "YKTN" painted somewhat smaller in the same location. *Lexington* and *Saratoga*, which had the same problem of looking very much like each other, had also used names painted on the flight deck and later introduced wide black stripes on the funnel — vertical for *Saratoga* and horizontal for *Lexington*. *Yorktown* started painting a large black "Y" on her funnel in 1938. *Enterprise* appears to have had no similar marking.)

Enterprise's armament at launch appears to have also been the same as *Yorktown*'s. However, being based first at San Diego and later at Pearl Harbor, she had somewhat better access to docking and equipment. For example, she appears to have received a newer radar, the improved CXAM-1, about the same time *Yorktown* had her CXAM installed. (The CXAM-1 differed from the CXAM in having a nonelevating antenna with more reliable rotation servomotors, which served to improve its accuracy.) She had four 1.1-inch mounts added fore and aft of her island, probably early in 1939.

Enterprise had modifications to her bridge before the war broke out, but they were less extensive than on *Yorktown*. In the place of the prominent wind-deflector added to *Yorktown*, *Enterprise* had her navigation bridge enclosed and provided with small portholes high up the face of the new structure. The small rangefinder was removed from the roof of her pilothouse, and splinter shielding was added there and around her AA emplacements.

By late May 1942, she had all 24 of her .50-caliber mounts replaced by single 20 mm mounts and had 10 additional mounts added as well. Two of those were at the bow, where a pair of 1.1-inch mounts would have been fitted had they been available. The rest were sited along the outboard side of the island, in space that had formerly been used to store boats. Unlike *Yorktown*, *Enterprise*'s boat crane was not removed at the same time. By this time, degaussing cables had been added, running outside her hull amidships.

After the Battle of Midway, six more 20 mm mounts were added — four were placed at the round-down (the very back end) of the flight deck right aft and four were added to her portside gallery, two of which had been moved from the bow, where a single 1.1-inch quad mount was finally installed. At the same brief post-battle refit, FD radars were added to her Mk 33 directors and an SG surface-search radar was added at the top of her foremast, replacing the YE homing beacon that had formerly occupied that position. (The SG radar was the U.S. Navy's first centimetric radar and the first to incorporate a plan position indicator [PPI] display, making it popular in the fleet.) She retained her CXAM-1 air-search radar. Her three catapults were removed at this time, both to reduce top weight and because they were rarely used.

Having received significant damage at the Battle of the Eastern Solomons in late August 1942, *Enterprise* headed to Pearl Harbor for repairs and some much-needed work on her AA and radar systems. At that time, the four 1.1-inch quad mounts around her island were replaced by quad 40 mm Bofors. It appears that while the two mounts forward of the island and the Number 4 mount at the flight deck level aft of the island were simply replaced, the superfiring mount aft of the island was relocated farther aft at the starboard deck-edge. Each 40 mm mount had a Mk 51 director sited nearby. (The Mk 51 director was a more sophisticated apparatus than the Mk 44. It incorporated gyroscopes that sensed the movement of the sight as a target was tracked and an electro-mechanical computer that used inputs from the gyroscopes to predict where to aim the weapon.) Eight more single 20 mm mounts were added to the deck-edge galleries, bringing the total of these mounts to 46. (It appears that the 1.1-inch quad mount at her bow was not replaced at this time. Sources differ and there's a lack of clear photographic evidence on this point, but later evidence makes more sense if it's assumed that the 1.1-inch mount at the bow

was retained until mid-1943.) A backup air-search radar, the recently deployed SC-1, was added. The new 8-foot-6-inch-by-7-foot-6-inch antenna was mounted on an outrigger extending outboard from her funnel. (The SC-1 provided performance similar to the CXAM series with a much smaller and lighter antenna by boosting power to double that of the earlier model.)

The 40 mm Bofors, of Swedish design, was extremely popular, especially when compared to the troublesome 1.1-inch guns it replaced. The standard AA round was 1.99 pounds with a bursting charge of 2.4 ounces. This was double the mass and charge of 1.1-inch rounds, making them far more effective at knocking down an onrushing aircraft. With a sustainable rate of 114 rpm per barrel, the Bofors actually fired faster than the 1.1-inch gun. The only downside to this weapon was its weight — a twin 40 mm mount weighed slightly less than a 1.1-inch quad mount. A 40 mm quad mount weighed at least 23,200 pounds, more than double the weight of a 1.1-inch quad. The original plan had been to replace the quad 1.1-inch mounts on *Enterprise* with twin 40 mm mounts, but this plan wasn't followed, resulting in the concern for the carrier's stability.

All of this added top weight raised serious concerns, particularly after her damage at the Battle of Santa Cruz, at which the second of her two sisters had also capsized before sinking. A proposal was put forward at this time to add a blister to her hull to increase stability and resistance to torpedo damage. However, the facilities at Nouméa where she was repaired in November 1942 were not adequate to allow that extensive a modification and, even more of an issue, with the torpedoing of *Saratoga* in late August and the loss of *Hornet* at the Battle of Santa Cruz, *Enterprise* was the only operational U.S. aircraft carrier in the Pacific for two months. She could not be spared for a lengthy yard visit, no matter how important. It was not until mid-July 1943 that she began her first major overhaul.

Repaired and Partially Rebuilt

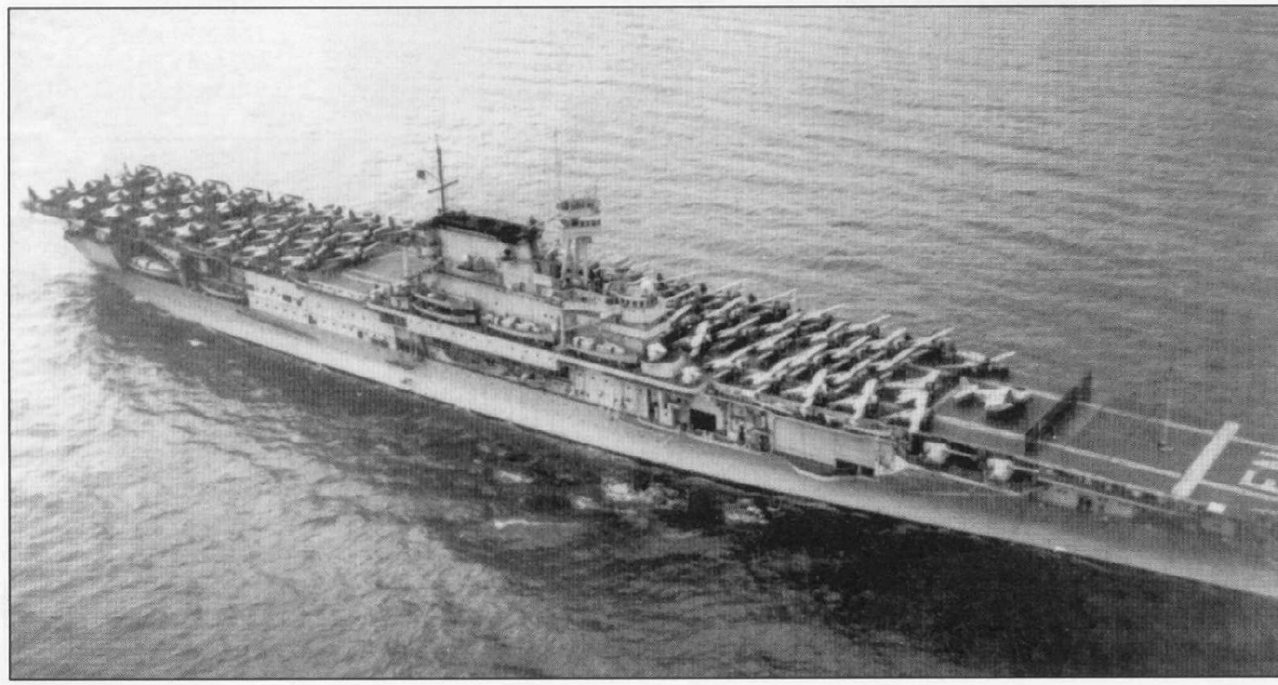
When *Enterprise* emerged from the yard, she was not only repaired but to a great extent rebuilt. The least visible change was the most important. The new hull blister that stretched most of the length of the hull faired into her existing structure so well that in many photographs the only hint that she had a blister was that her hull sides were now vertical at the waterline. This increased her beam at the waterline by 12 feet 3 inches to 95 feet 5 inches. Her full-load displacement increased to 32,060 tons. Taking advantage of the increased stability and buoyancy the blister brought, her AA suite was greatly increased. She still carried eight 5-inch/38 guns in single mounts, but these were now upgraded to Mk 24, Mod 11 mounts with RPC, controlled by a pair of new Mk 37 fire control directors mounting FD radars replacing the old Mk 33 directors.

The four existing 40 mm quad mounts were retained, and two additional mounts were sited at the hangar deck level portside aft. Eight twin 40 mm mounts were added as well. One replaced the gun mount at the bow, two were added to each side of the flight deck forward of the forward 5-inch battery, one more was added on each side of the flight deck aft of the aft 5-inch battery, and the final was added into the superfiring position aft of the island, where a 1.1-inch mount had been removed in November 1942. Every 40 mm mount was provided with an off-mount Mk 51 director. She retained her massive battery of 46 single 20 mm mounts and had two more single mounts added, plus experimental twin and triple mounts. These latter were found to be unwieldy in practice and were soon replaced by single mounts.

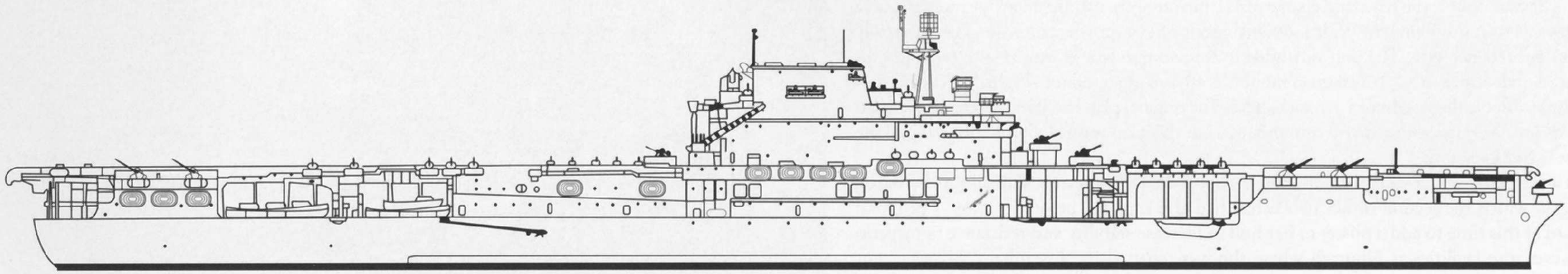
During the same refit, *Enterprise*'s radar suite was upgraded. An SK radar replaced the now ancient CXAM-1. This antenna was sited at the forward edge of her fighting top to make room for an SM conical scan height-finder antenna at the after edge. This radar was intended for fighter direction in defense of the fleet. The SM's antenna was an 8-foot dish on a heavy conical base that allowed the antenna to "nod" while it scanned. The entire SM setup was so heavy that it could only be fitted to large aircraft carriers. The SC-1 backup air-search radar was replaced by an SC-2, which featured improved electronics and a wider 15-foot-by-4-foot-6-inch antenna. (The SK in fact used the same electronics as the SC-2,

The only distinguishing markings on *Enterprise* was the painting of the letters "EN" very large at ends of her flight deck. Running trials before her commissioning, *Enterprise* is in strictly "as-built" condition, 6 April 1938. Like *Yorktown*, she has the triangular message board structure that would soon be removed. The flight deck was designed to "bulge" toward port amidships to keep a constant width around the island. *(NARA)*

By 12 April 1939, *Enterprise* has now received her four quad 1.1-inch mounts, here under canvas covers. Again, her forward palisade is raised to protect her deck-load of aircraft. Her foretop has four .50-caliber machine guns that would be displaced by the CXAM-1 antenna in 1941. *(NARA)*



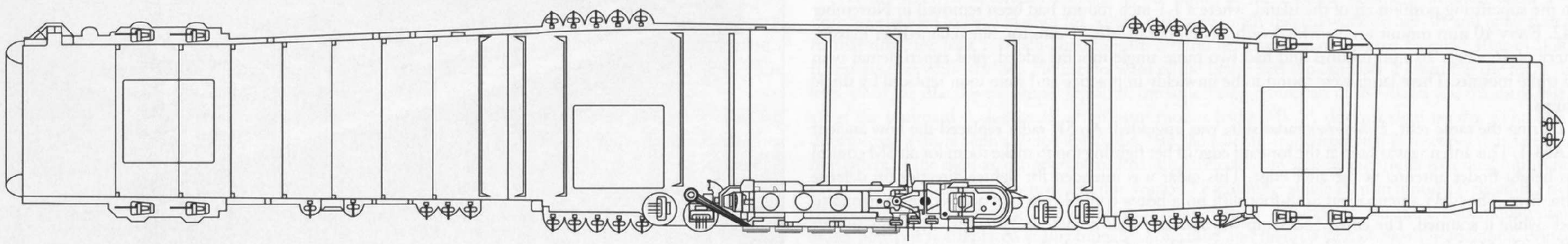
Enterprise (CV 6) in 1942

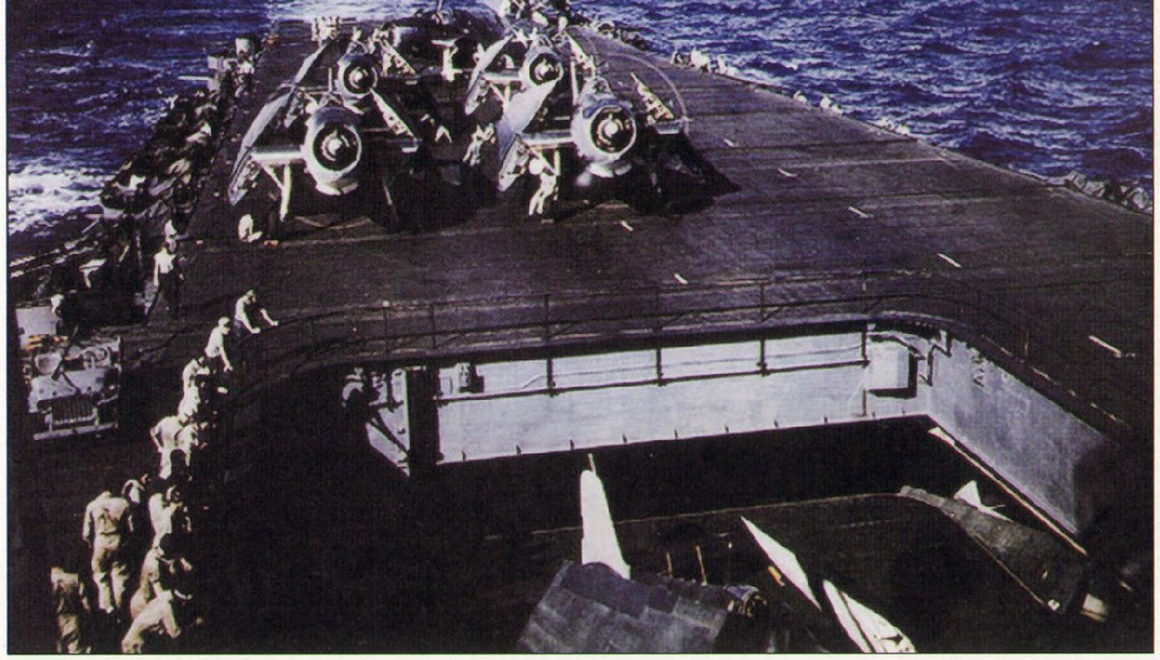


Enterprise Specifications

Built	March 1938
Length overall	809 feet 6 inches
Length of water line	770 feet 0 inches
Beam (waterline)	83 feet 2½ inches
Beam (exterior)	109 feet 6¼ inches
Hull depth	79 feet 8 inches
Speed (design)	32.5 knots
Speed (trial)	33.65 knots
Hangar clear height	17 feet 3 inches
Flight deck	802 feet x 86 feet
Hangar deck	546 feet x 63 feet

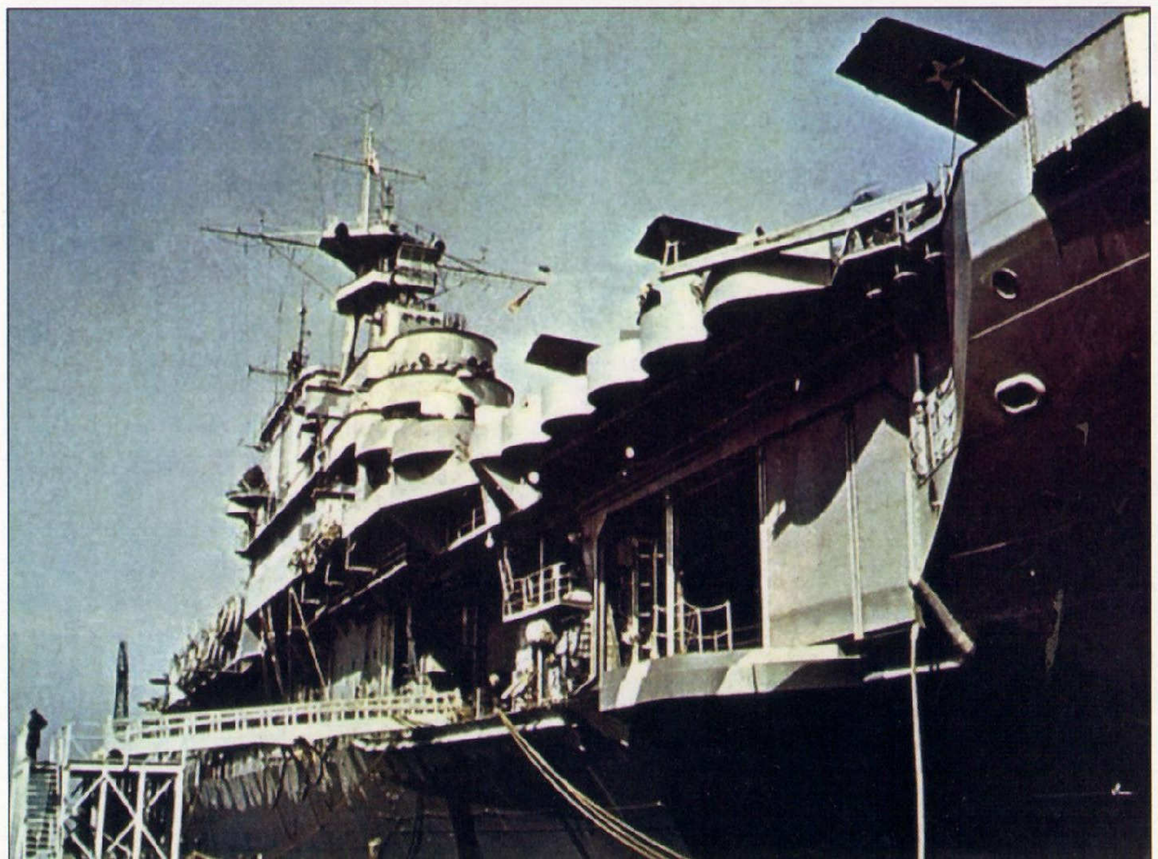
Capacity	17,000 tons
Catapults	3 H 2
Arresting gear	Mk 4
Fighters	18 (36 F6F-3 — 1943 air group)
Bombers	18
Scouts	37 (SBD-5)
Torpedo bombers	18 (TBF-1)
Other	5 VJ, 1 VM
Armament	8 single 5-inch/38 gun mounts, 4 quad 1.1-inch/75 machine gun mounts, 24 .50-caliber machine guns
Crew in 1941 (ship's company and air wing)	2,217

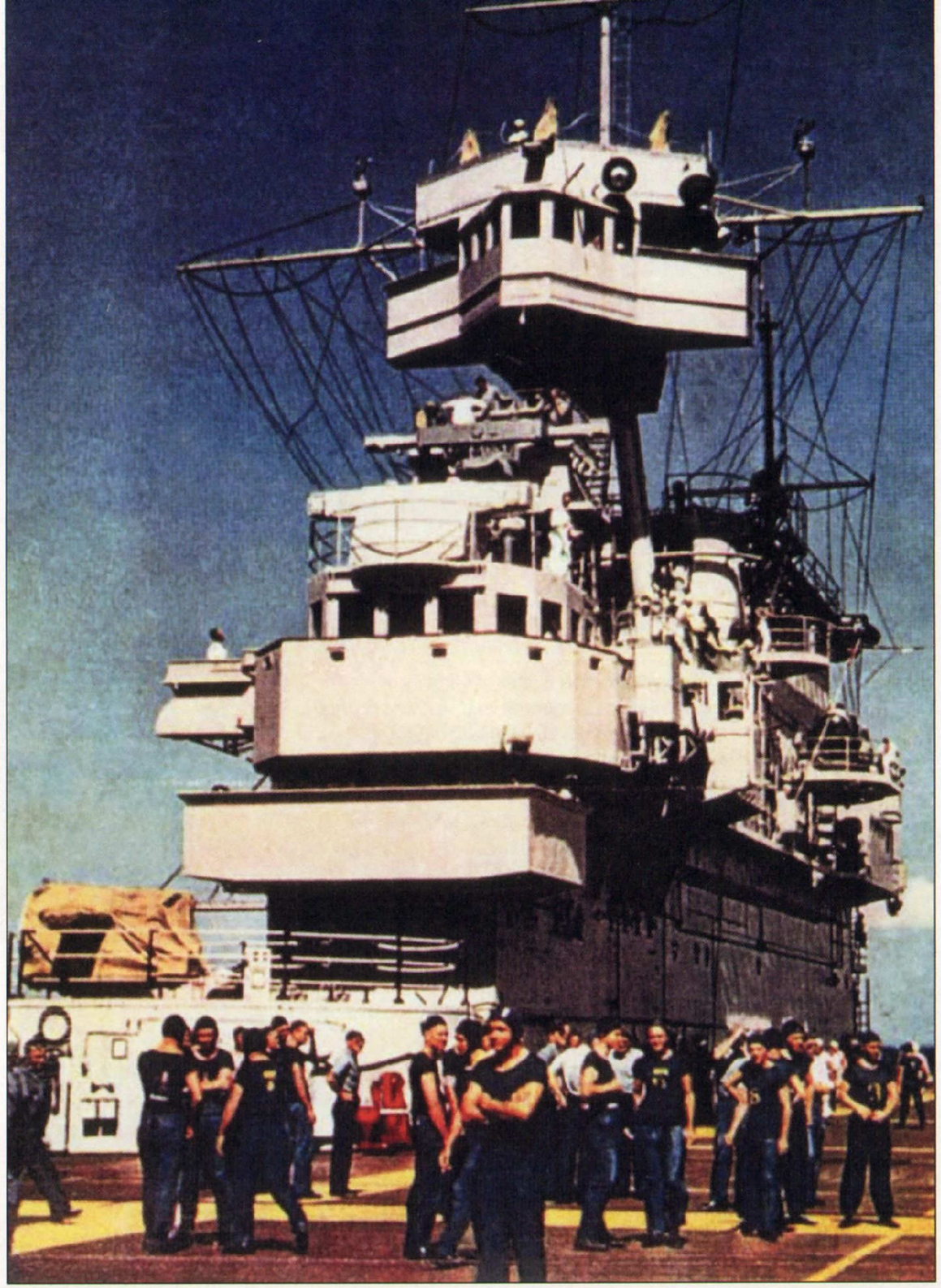




Four TBF-1 Avengers of VT-10 warm up aft on *Enterprise* in May 1944 while an F6F-3 Hellcat was being brought up on the aft elevator. This photograph was taken with Kodachrome slide film, known for its color fidelity, but this image has a noticeable blue cast. At this time, the carrier's flight deck had a freshly applied coat of Deck Blue stain (20-B). This stain lost its pigmentation quickly due to sun, salt, and general wear and tear, and had to be reapplied regularly. *(NHC)*

On 27 March 1942, *Hornet* was docked at North Island, San Diego, California, where she loaded her air group prior to setting off for the war in the Pacific. She was painted in an elaborate Ms 12 Mod camouflage scheme — a three-color scheme using Sea Blue (5-S), Ocean Gray (5-O), and Haze Gray (5-H). As this photograph (which has a slight yellow cast) demonstrates, these colors, which were made by mixing a purple-blue tinting material in a white base, in fact rapidly lost any blue cast they may have had because the blue pigment faded quickly in sunlight. In practice, the colors were shades of neutral gray. *(NARA)*

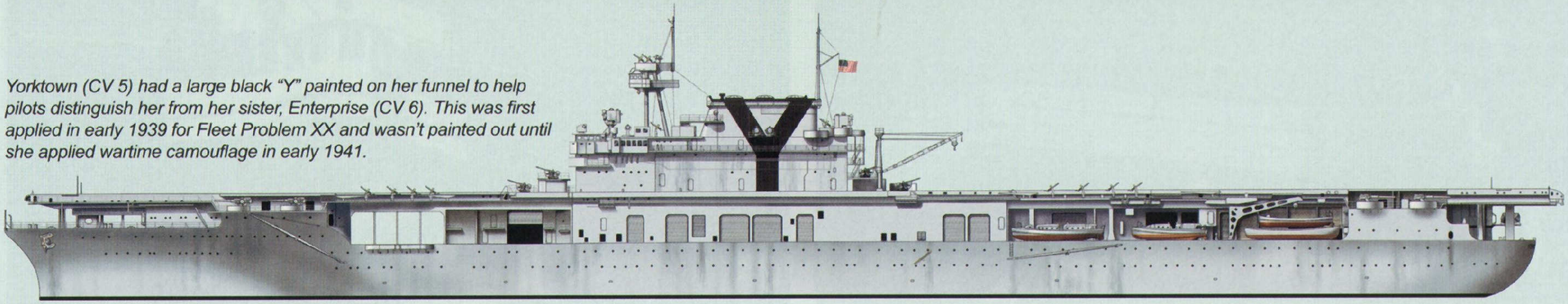




Before she was painted in Ms 1, *Enterprise* wore the peacetime scheme of overall Haze Gray (5-H), early 1941. Her flight deck was stained reddish-brown, and deck striping was chrome yellow. This made for excellent visual contrast for pilots, but also made her easy to spot by potential enemies; both the stain and the yellow stripes were sacrificed as war approached. The number 2 1.1-inch AA mount, on the deckhouse to the left, was under a tan canvas cover to protect this delicate weapon from the weather, as are the three .50-caliber machine guns visible on the foretop. *(NHC)*

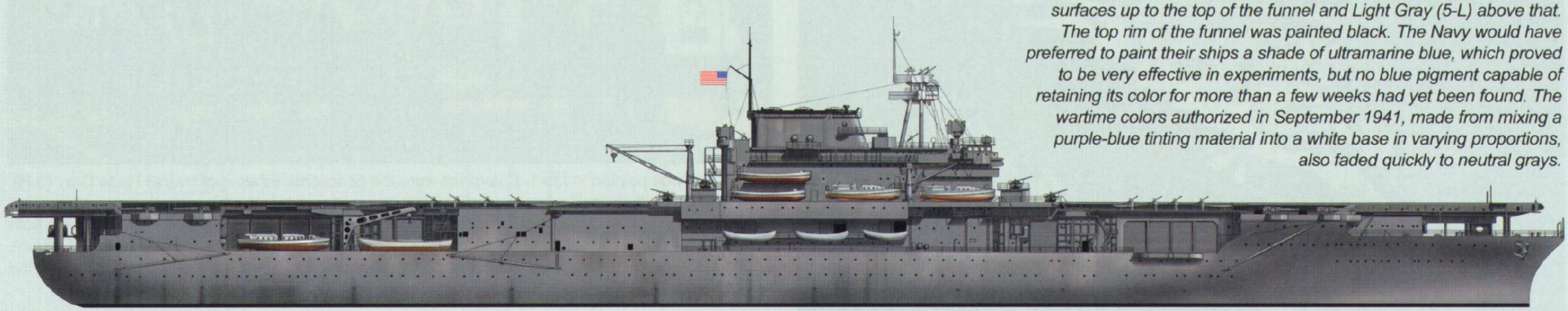
Yorktown-Class Aircraft Carriers in Color

Yorktown (CV 5) had a large black "Y" painted on her funnel to help pilots distinguish her from her sister, Enterprise (CV 6). This was first applied in early 1939 for Fleet Problem XX and wasn't painted out until she applied wartime camouflage in early 1941.



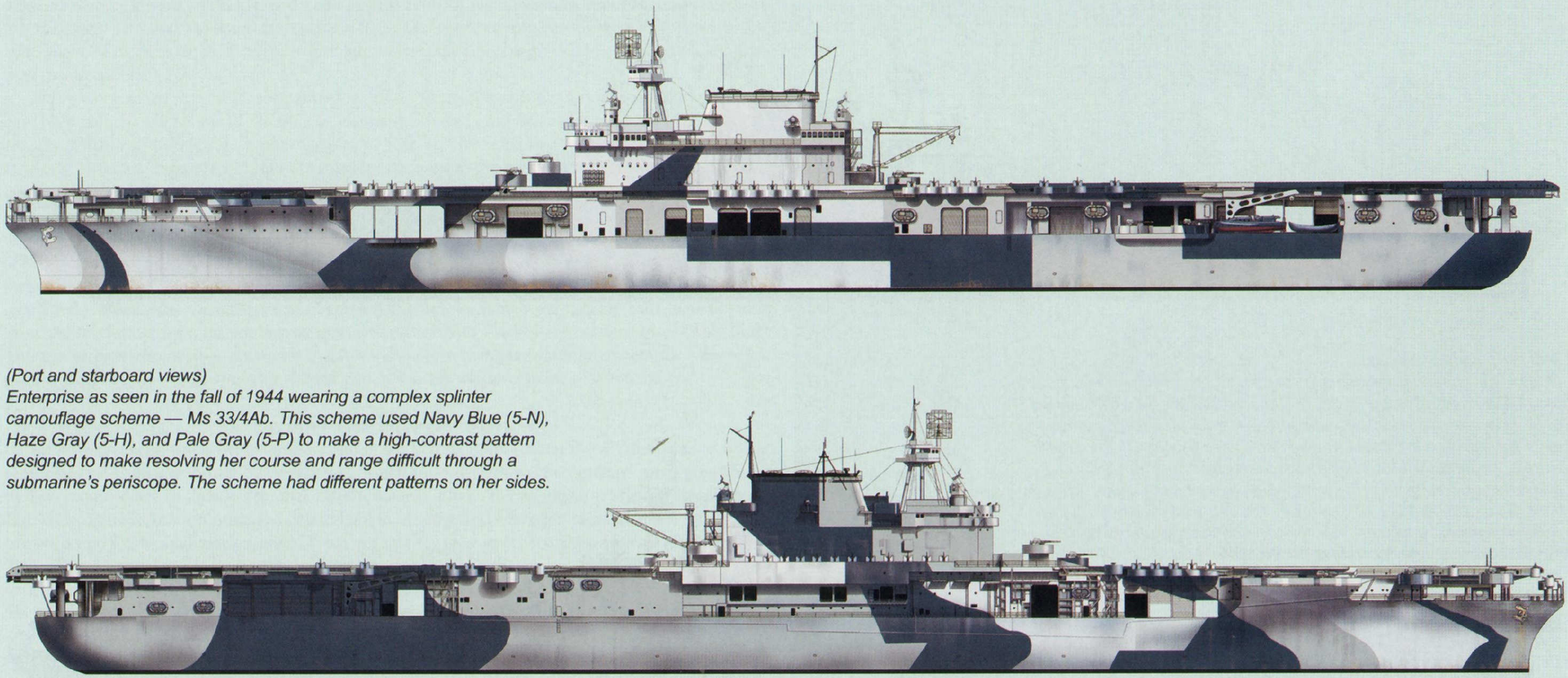
Yorktown, at the time of her loss after the Battle of Midway, 7 June 1942, was painted in the Ms 12 scheme that used horizontal bands of Sea Blue (5-S), Ocean Gray (5-O), and Haze Gray (5-H) in an attempt to blend in with the horizon.

Enterprise briefly wore Ms 1 in mid-1941. This was considered to be a compromise scheme, which had Dark Gray (5-D) on all vertical surfaces up to the top of the funnel and Light Gray (5-L) above that. The top rim of the funnel was painted black. The Navy would have preferred to paint their ships a shade of ultramarine blue, which proved to be very effective in experiments, but no blue pigment capable of retaining its color for more than a few weeks had yet been found. The wartime colors authorized in September 1941, made from mixing a purple-blue tinting material into a white base in varying proportions, also faded quickly to neutral grays.



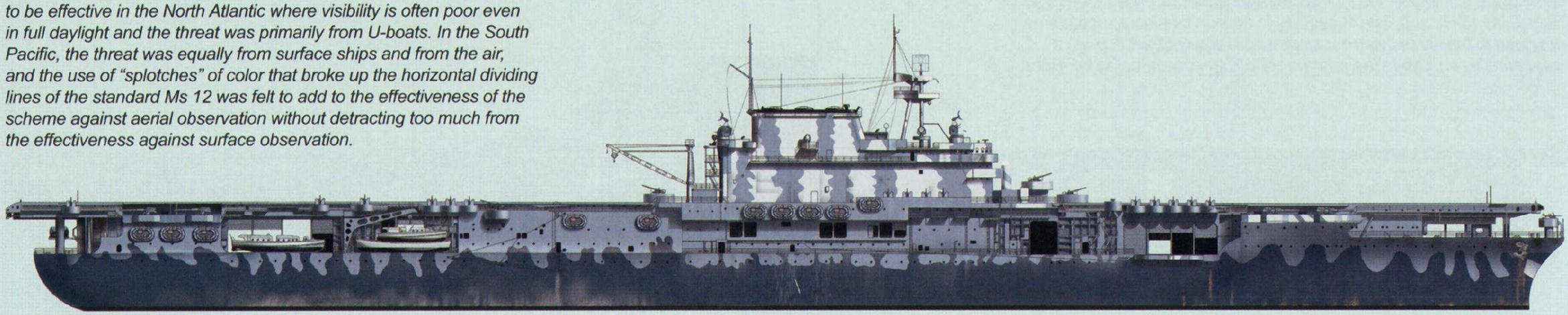
At the time of the Battle of Midway, Enterprise was painted in Ms 11 — overall Sea Blue (5-S), June 1942. This scheme was considered particularly effective against observation from the air.

(Port and starboard views)
Enterprise as seen in the fall of 1944 wearing a complex splinter camouflage scheme — Ms 33/4Ab. This scheme used Navy Blue (5-N), Haze Gray (5-H), and Pale Gray (5-P) to make a high-contrast pattern designed to make resolving her course and range difficult through a submarine's periscope. The scheme had different patterns on her sides.



After her major 1943 refit, Enterprise emerged painted in Ms 21, overall Navy Blue (5-N). This scheme was highly effective against observation from the air unless the Deck Blue (20-B) stain on the flight deck had weathered to near-transparency — which would have allowed the pine decking to show through — or the ship was moving at high speed and trailing a big wake.

(Port and starboard views)
Hornet was painted in this modified version of Ms 12 known as Ms 12 Mod before sailing for the Pacific, February 1942. Ms 12 was intended to be effective in the North Atlantic where visibility is often poor even in full daylight and the threat was primarily from U-boats. In the South Pacific, the threat was equally from surface ships and from the air, and the use of "splotches" of color that broke up the horizontal dividing lines of the standard Ms 12 was felt to add to the effectiveness of the scheme against aerial observation without detracting too much from the effectiveness against surface observation.



achieving better resolution because it used a larger 17-foot-by-17-foot antenna.) Both air search radars incorporated a rectangular auxiliary antenna at the top edge for IFF. A second SG radar was added at the top of her mainmast. (The net effect of the multiplication of radars and other sensors in the limited real estate on top of an aircraft carrier's island was that they tended to block each other in certain sectors, which led to the fitting of yet more radars to cover the blind spots.)

To take advantage of the much improved electronics, *Enterprise*'s bridge structure was heavily modified. The flag bridge was deleted, the space being taken up by a rudimentary Combat Information Center (CIC) that would allow the information from the SM and the two air search radars to be integrated and used for fighter control. The enclosed navigation bridge was replaced by a larger, open semicircular structure, and the pilothouse was rebuilt smaller and with a rounded face. The lookout station on the pilothouse roof was rebuilt and now incorporated a searchlight position projecting from its forward face. The large, enclosed Primary Flight Control (Pri-Fly) at the navigation bridge level just aft and inboard of that bridge was reduced in size and given an open position for the air boss (the air operations officer who controlled all flight deck activity) on its roof.

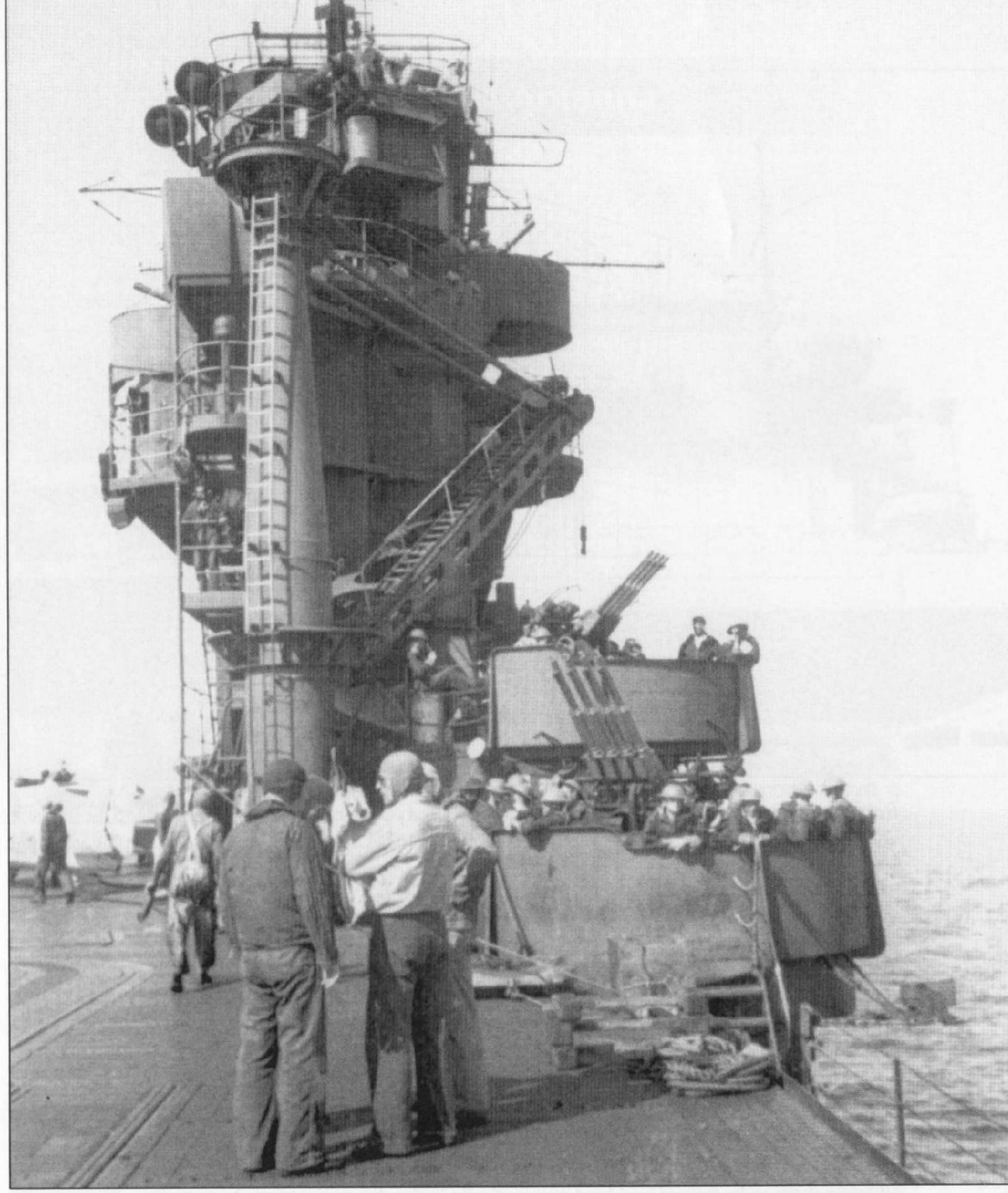
Enterprise's hull was permanently degaussed at this refit, which allowed the removal of the degaussing coils around the hull below the hangar deck. External avgas piping was put in its place. Her flight deck was lengthened aft by 18 feet. She received two flight deck catapults at this time. These were H 2-1 models set at an inward angle, giving up any possibility of launching aircraft simultaneously from the two catapults. This and the lengthening of the flight deck were concessions to the ever-increasing size and weight of carrier aircraft. Clearly, in the future, catapult launching would become the rule rather than the exception.

Enterprise emerged from this refit painted in Ms 21 overall Navy Blue camouflage. (She appears to have been painted Ms 11 overall Sea Blue, a scheme she carried until this major refit. Ms 11 and Ms 21 are very difficult to distinguish in photographs, as both rapidly faded to a medium- to dark-blue-gray tone. Ms 21 is darker than Ms 11, but the apparent darkness in photographs is greatly influenced by the brightness and angle of the sun.) This changed in May 1944, when, back at Pearl Harbor for a brief refit, she was painted in Ms 33/4Ab light splinter pattern. This measure and pattern used hard-edged panels of Pale Gray (5-P), Haze Gray (5-H), and Navy Blue (5-N), all arrived at by mixing various proportions of blue-black tinting material (5-TM) in a pure white base (5-U). (When fresh, the paints had a decided purple cast, but this rapidly faded into various shades of blue-gray, with the blue fading as well as the paint weathered.) When new, the dark panels of this scheme were extremely dark, being hard to distinguish from the black boot topping, leading to speculation that Dull Black was used instead of Navy Blue. This can be neither proven or discounted, as it is well-known that navy yards often bent the rules when painting ships in the various mid-war splinter patterns, using whatever paint was on hand.

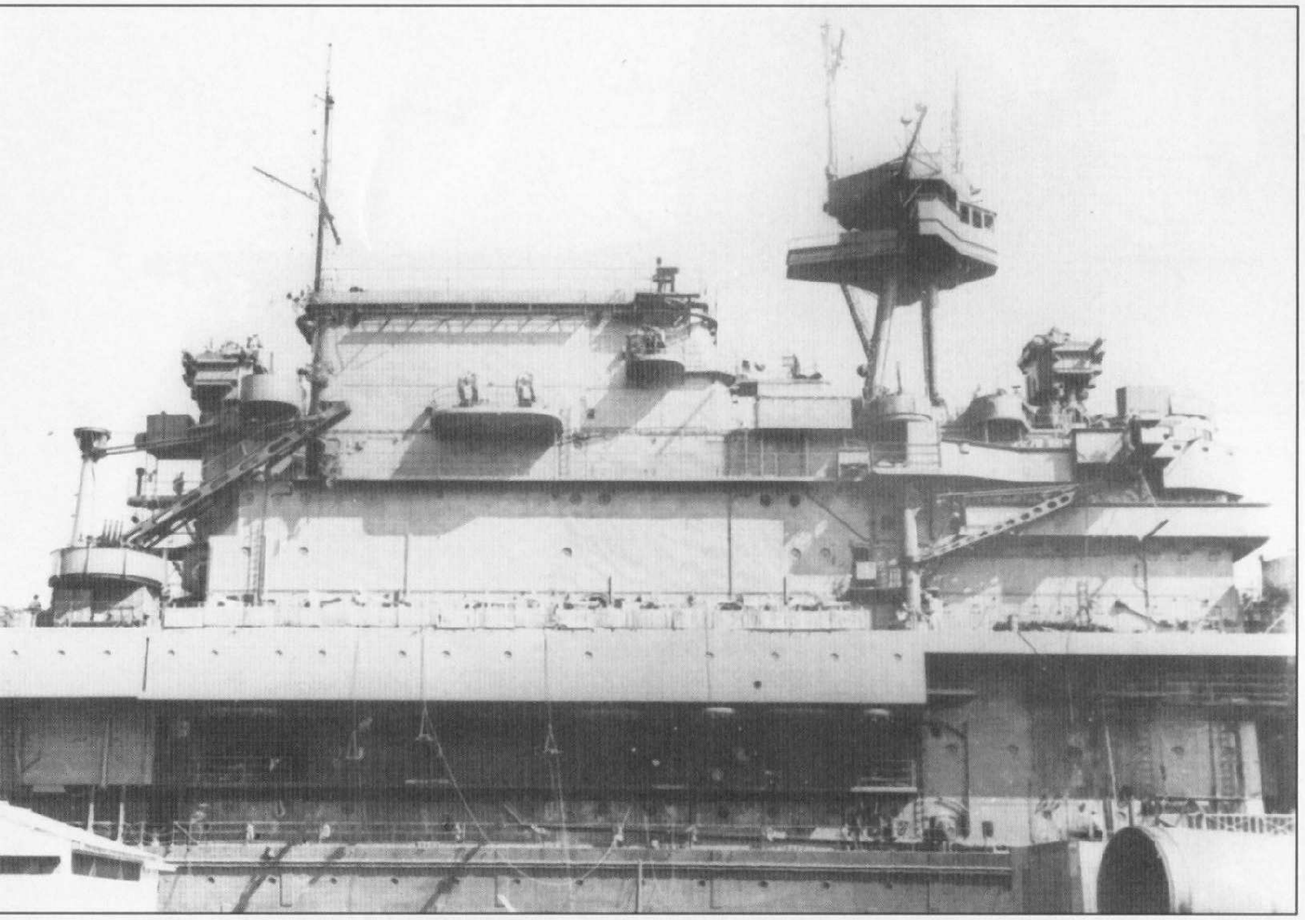
Splinter Camouflage Pattern

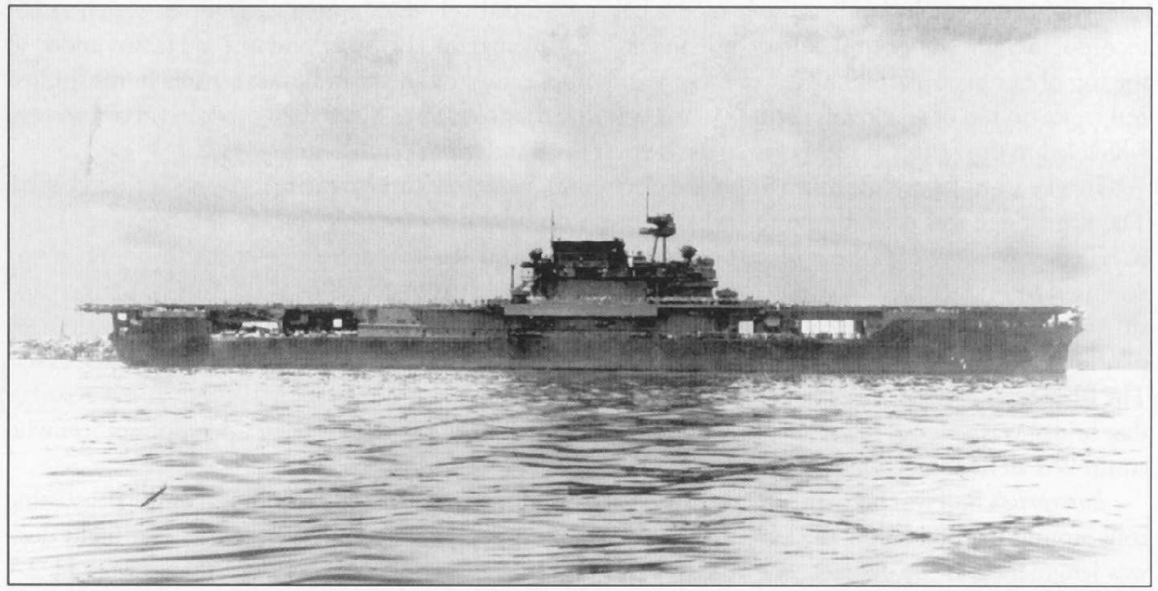
Enterprise retained this scheme until the end of the year. Splinter schemes were considered to be the most effective against detection by submarines, which in mid-1944 were considered the biggest threat to U.S. surface ships. In theory, a splinter pattern merged into an overall gray tone viewed at a distance, and when sighted closer up made the determination of range and bearing more difficult, both essential parts of a solution to a submarine attack. From the air, they were less effective than overall dark schemes, such as Ms 11 and Ms 21. By late in the year, the assessment of the enemy threat had changed again, with aircraft, in the form of kamikazes, again seen as the bigger threat, and *Enterprise* was again painted in Ms 21 when back at Pearl Harbor in December. She retained this scheme for the rest of the war.

Before the war, *Enterprise*'s flight deck had been regularly treated with a reddish-brown varnish, which would fade between treatments to a pale wood color. Deck stripes and other markings were chrome yellow. As war approached, her flight deck was stained deck blue in July 1941. It remained this color for the duration of the war. Deck striping was reduced and painted in white or light gray. In some photographs from late 1942, it appears as if the flight deck has no markings at all. When she emerged



This view of the aft end of *Enterprise*'s island shows her appearance soon after the start of the war, February 1942. She is painted in Ms 1, the earliest wartime camouflage. This was overall Dark Gray (5-D), a neutral gray with no bluish cast. This paint wore very unevenly and faded quickly, causing it to be replaced by the purple-blue paints used throughout the rest of the war. Although most of her .50-caliber machine guns have been replaced by 20 mm Oerlikons, two of these guns can be still be seen aft of the funnel on either side of the base of the Mk 33 director. The sailors in the foreground stand next to the long, narrow torpedo elevator, which was immediately to the starboard of the midships aircraft elevator. *(NARA)*





(Above) Having missed the action in the Coral Sea by only days, *Enterprise* rushed back to Pearl Harbor, where she arrived on 26 May 1942, the most likely date for this photograph. She still wears the Ms 11 camouflage, which now appears much darker, given the overcast sky. *(NARA)*

(Left) Eight single 20 mm mounts have been fitted in the boat stowage at the flight deck level outboard of *Enterprise*'s island. Unlike *Yorktown*, she retained her boat crane. While she also retained at least two .50-caliber mounts aft of her funnel, it appears that the mount at the base of her tripod foremast is now a 20 mm mount. Her newly fitted CXAM-1 radar antenna is at the front edge of her foretop. Degaussing cables run along her hull amidships. Her camouflage is now Ms 11 overall Sea Blue, which appears quite light because it's in strong sunlight. *(NHC)*

from the 1943 refit, she had her hull number painted very large on her flight deck fore and aft in black, and she once again had narrow-dashed white deck striping. Later, in 1944, the deck striping got more visible with broader dashes.

In this form, *Enterprise* fought until seriously damaged by a kamikaze attack off Okinawa on 14 May 1945, forcing her out of the war for good. She made it back to the West Coast, arriving at the Puget Sound Navy Yard, Bremerton, Washington, at the beginning of June. Unlike *Saratoga*, the other carrier that had fought the entire war and had also been damaged by kamikazes in 1945, *Enterprise* was fully repaired. She emerged from this repair and refit with 10 40 mm quad mounts and five twin mounts, an increase in total mounts by one. Two quad mounts were added at the hangar deck level in a new sponson in the catapult bay forward on the port side. Two of the existing twin mounts, the forwardmost on either side of the flight deck, were replaced with quad mounts. The existing twin mount at the extreme bow was removed. (Most sources give the medium AA suite after this refit as having 11 40 mm quad mounts, the additional mount being located at the deck edge on the port side. However, examination of photographs does not show this mount.) All 40 mm mounts had remote power control (RPC) fitted, allowing them to be trained and fired automatically under director control. To partially compensate for the added weight of this 40 mm battery, the 20 mm battery was reduced to 16 twin mounts.

While her main radars were unchanged in this refit, she had a major augmentation in her fire control setup. Four small radar-controlled Mk 57 Gun Fire Control System (GFCS) directors were added, one near each pair of 5-inch guns, to provide local control for each quadrant. (The Mk 57 GFCS was a Mk 51 director modified to take range inputs from a Mk 19 or similar radar. It was considered a "blind fire" system, meaning that it could be operated without visually sighting the target, as it could be aimed by keeping the target centered in the radar scope. The antenna for the Mk 19 radar was a 24-inch circular mesh paraboloid.) The Mk 57s could be linked to control all the heavy and medium AA guns in a quadrant. However, local control for the 40 mm battery was provided in the form of four Mk 63 directors. This provided capabilities similar to the Mk 57 in a somewhat smaller package. It used the newer Mk 34 radar with a 30-inch parabolic dish. There were also 11 additional Mk 51 directors without radar, which meant that each 40 mm mount could be individually director-controlled.

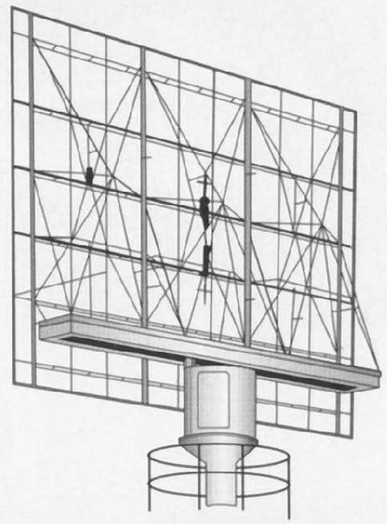
This was *Enterprise*'s final form. She emerged from this refit just as the war was ending and remained in this condition throughout her brief postwar career. The only further change made to her was not visible from the outside. After spending Navy Day (October 27) 1945 at New York City, she proceeded to Boston, where, at the navy yard there she had her hangar deck converted to a berthing space, after which she undertook four "Magic Carpet" missions, returning demobilized U.S. troops from Europe.

Operational History

Of the six operational aircraft carriers in commission in the U.S. Navy at the time of the Pearl Harbor attack (counting *Hornet* and not counting *Ranger*, which operated in the Atlantic throughout the war), only two — *Saratoga* and *Enterprise* — survived the war. As could only be expected for a warship in such a situation, *Enterprise* had a long and active operational career. Only the high points will be covered here.

Enterprise worked up after her commissioning with a cruise that took her as far as Rio de Janeiro. After her post-shakedown yard period, she served briefly in the Atlantic until April 1939 when she transferred to the Pacific Fleet, where she remained until late 1945. Her primary occupation before the war, besides training her air group, was transporting air units to various Pacific bases. She was returning to Pearl Harbor from one such mission, delivering Marine Fighter Squadron (VMF)-211 to Wake Island,

CXAM-1 Antenna



The CXAM-1 was an improved version of the CXAM.

(Left) A scouting mission is launched off *Enterprise* in the Coral Sea, mid-May 1942. The guns under canvas covers in the portside gallery are all 20 mm Oerlikons. *Hornet* and the anti-aircraft cruiser *Atlanta* (CL 51) are in the background toward the right. The diagonal white stripe on the tail of these Dauntlesses isn't a unit marking; it's an aid for the landing signals officer (LSO) who guided aircraft on approach to the carrier. If he could see the stripe just above the wing of an approaching aircraft, it was on a correct glide slope. *(NARA)*

when the Japanese attacked. By pure luck, she was not in harbor as she normally would have been on a peacetime Sunday morning, where she would have been a high-priority target.

The early months of hostilities were spent patrolling off Hawaii and protecting troop convoys to Samoa. Her first strike at the Japanese came on 1 February 1942, when her aircraft struck several bases in the Marshalls. After strikes at Wake and Marcus Islands in March, she escorted *Hornet* in April as her sister carried a deckfull of Doolittle's U.S. Army Air Forces (USAAF) B-25s within range of Tokyo. After resupplying at Pearl Harbor at the end of the month, she set off with her sister at high speed for the South Pacific, but they arrived too late to take part in the Battle of the Coral Sea.

New intelligence warned of another major Japanese move, this time in the Central Pacific, and she turned around and headed back to Pearl Harbor, again at high speed, arriving there on 26 May. Two days later she sailed toward Midway with *Hornet*, followed in another two days by the hastily repaired *Yorktown*. The battle that followed on 4 June was a decisive early turning point in the war. *Enterprise*'s dive bombers delivered the blows that demolished *Kaga* and *Akagi* in the morning attack on the Japanese fleet and accounted for *Hiryu* later in the day. Neither she nor *Hornet* was damaged in the Japanese counterattacks.

Overhauled at Pearl Harbor after that battle, she set out for the South Pacific again in mid-July to support the landings at Guadalcanal and face the inevitable Japanese reaction. On 24 August 1942, she fought the Battle of the Eastern Solomons, in which *Enterprise*, *Saratoga*, and *Wasp* faced the surviving Pearl Harbor veterans *Shokaku* and *Zuikaku*, along with the small carrier *Ryujo*. The battle was something of a draw, with *Ryujo* being sunk by *Saratoga*'s aircraft, and *Enterprise* receiving three direct hits by bombs and four near-misses. In the aftermath, the Japanese called off a planned reinforcement of their troops on Guadalcanal, which was the reason for this operation in the first place.

Enterprise's damage was major, with two out of three elevators out of action, but never life-threatening, and she headed back to Pearl Harbor for a month of repairs. She departed again for the South Pacific on 16 October to join *Hornet*. (*Saratoga* had been torpedoed on 31 August and *Wasp* sunk by torpedoes on 15 September, meaning that for more than a month the Americans had only *Hornet* holding the line in the South Pacific.) On 26 October 1942, *Enterprise* was in action again at the Battle of Santa Cruz, where, along with *Hornet*, she faced her old nemeses *Shokaku* and *Zuikaku*, this time supported by the light carrier *Zuiho* and the liner conversion *Junyo*. The two sides found each other at almost the same time. Two large attack groups from the four Japanese carriers sent 62 aircraft against *Hornet* and 77 against *Enterprise* in several waves. Almost half the attackers were shot down by the American CAP, but enough got through to fatally damage *Hornet* and put two bombs into *Enterprise* and near-miss her with another.

Again, her damage was serious, but not fatal, and she remained operational, recovering her aircraft and most of *Hornet*'s. In return, the Americans managed only to damage *Shokaku* and *Zuiho*, making this a tactical victory for the Japanese, but they were unable to exploit the situation as their carriers needed to withdraw as well to repair and replenish. For a few weeks, no aircraft carrier of either side operated in the waters of the South Pacific. *Enterprise* withdrew only as far as Nouméa, where she was repaired and received some quick upgrades to her AA and electronics, sailing again on 11 November to provide needed air support around Guadalcanal and participate in the Naval Battle of Guadalcanal. This time,

The large aircraft crane at the aft end of the island was immensely useful. Here it deposits a spare wing for an F4F Wildcat, transferred from the oiler *Sabine* (AO 25) in the Coral Sea, 12 May 1942. The wing is lacking flaps and aileron; the assumption was that these would be supplied from spares already onboard or from the damaged wing being replaced. In the deck edge gallery can be seen 20 mm mounts and one of the aft 5-inch guns. *(NARA)*

the Japanese had no carriers to oppose *Enterprise*, allowing her aircraft to decisively impact the surface engagements. The Japanese would be without an operational fleet carrier for over two months. It took *Zuikaku* until January 1943 to restore the losses to her air group and return to action; *Shokaku* was out of action for almost a year. (The Americans had done a better job of anticipating the human and matériel "costs" of war — and took advantage of a much larger population and industrial base — and were able to repair damaged ships and replace lost aircraft and air crew much faster than the Japanese.)

Enterprise operated without significant enemy opposition in the Solomons area until May 1943, when the availability of *Saratoga* and the British carrier HMS *Victorious* and the imminent arrival of the first war-construction carriers meant she could at last be spared for a long-overdue major overhaul. Even then, she spent two months in Hawaiian waters training new air groups before she was released to the yard at Bremerton.

The navy that *Enterprise* rejoined in mid-November 1943 looked very different than the one she had left in May. In the interim, a dozen new aircraft carriers, six of them "improved-*Yorktowns*" of the *Essex* class, had joined the war. For once, *Enterprise* was just one of many carriers providing air cover for landing operations and the rest of the fleet. She supported landings at Makin Island and strikes on Kwajalein in late-November. This deployment was notable in that *Enterprise* became the first U.S. aircraft carrier to operate aircraft specifically modified for night operations, when, on 26 November 1943, she launched three night fighters to protect the carrier group from night attack by land-based bombers.

She was in action again in January 1944, supporting the landings on Kwajalein. During the subsequent attack on the major enemy base at Truk (now Chuuk in the Federated States of Micronesia), she launched a night bombing raid, another first for a U.S. aircraft carrier. The rest of the spring was spent conducting raids in the Central and South Pacific.

This inexorable push by U.S. forces across the Central Pacific was bound to force a response by the Japanese. That happened in June, when *Enterprise* joined the massive armada supporting the landings in the Marianas and participated in the Battle of the Philippine Sea (also known as the Marianas Turkey Shoot).

After a brief stop at Pearl Harbor, she was back in action again in August. She supported strikes at the Volcano and Bonin islands and later at Yap and the Palaus. In October, the target was Okinawa, Formosa, and the Philippines; late in the month, she was part of Halsey's fast carrier group at the Battle for Leyte Gulf.

USN's First Night Aircraft Carrier

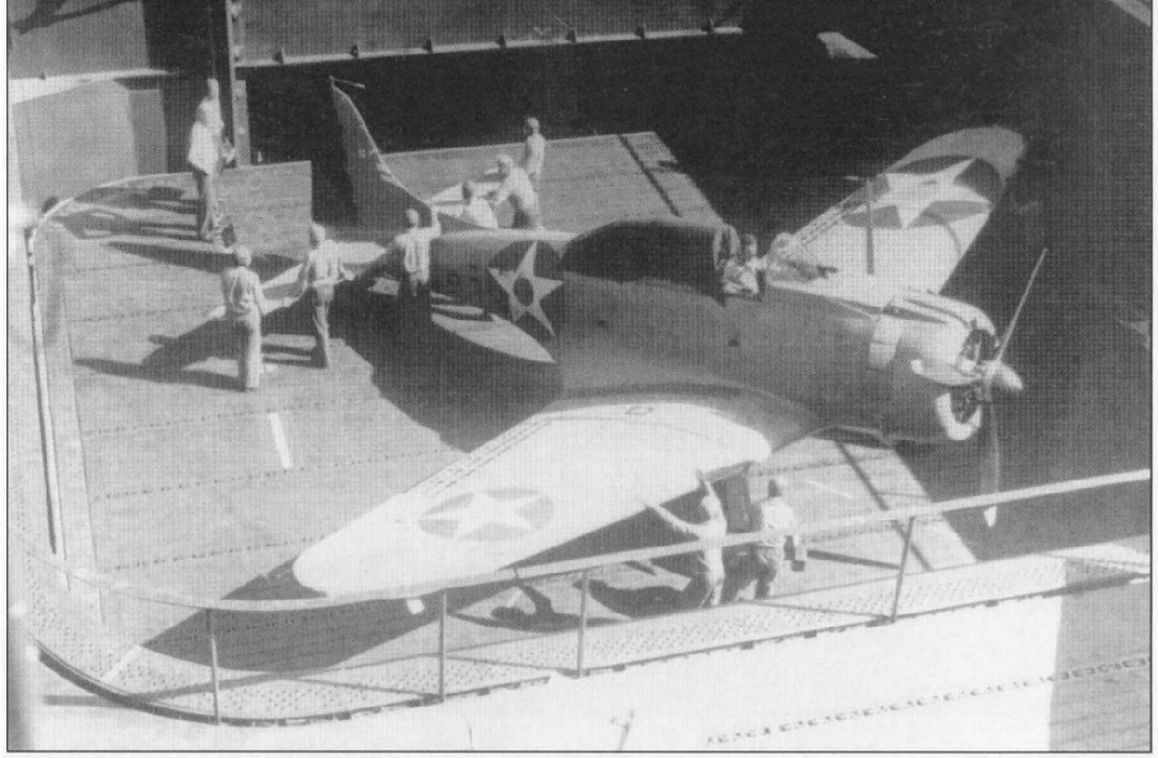
In late November, she returned to Pearl Harbor for another refit and a change in mission. Having pioneered night operations with the fleet, she emerged at the end of December as a dedicated night aircraft carrier, the first such in the U.S. Navy. She was part of TF 38 striking Luzon, Formosa, and Indochina in January 1945 and TF 58 attacking Tokyo in February. (TF 38 and TF 58 were made up of the same ships; the number changed as Halsey and Spruance took turns leading the U.S. fleet in the Pacific.) She supported the landings on Iwo Jima in February and further raids in March on the Japanese Home Islands.

She took some damage on 20 March. She'd been hit by a bomb two days earlier, but that failed to explode and caused no significant damage. On the 20th, she was again the target of a Japanese attack. Three bombs near-missed, causing no damage. However, a 5-inch shell fired by one of her escorts exploded over her flight deck forward, igniting several armed and fueled Hellcats awaiting launch. The fire rapidly spread among parked aircraft, setting off ready-service rounds at the 40 mm mounts forward of the island. Both mounts and Pri-Fly were burned out, putting *Enterprise* out of action again. Repaired at Ulithi, she was back in time to support the Okinawa landings in early April. She was hit by a single kamikaze on 11 April and again retired to Ulithi for repairs. She was back again off Okinawa on 6 May, but that deployment lasted only eight days. On 14 May, a kamikaze crashed through her flight deck forward and exploded in the hangar, buckling her flight deck and sending part of the forward elevator platform hundreds of feet in the air.

This damage finally drove her out of the war. She was fully repaired, but didn't emerge from the Puget Sound Navy Yard until September, too late to rejoin the war. She sailed for Pearl Harbor, but got no farther west. She returned stateside with 1,141 troops ready for discharge, a fate she wouldn't escape for long. She sailed for New York to celebrate Navy Day in October and then went on to Boston. From there she made four "Magic Carpet" runs across the Atlantic, bringing more than 10,000 servicemen home. Finally, in February 1946, she was decommissioned and passed into the Reserve Fleet, where she remained until sold for scrapping on 1 July 1958.

Highly Decorated Warship Not Preserved as a Memorial

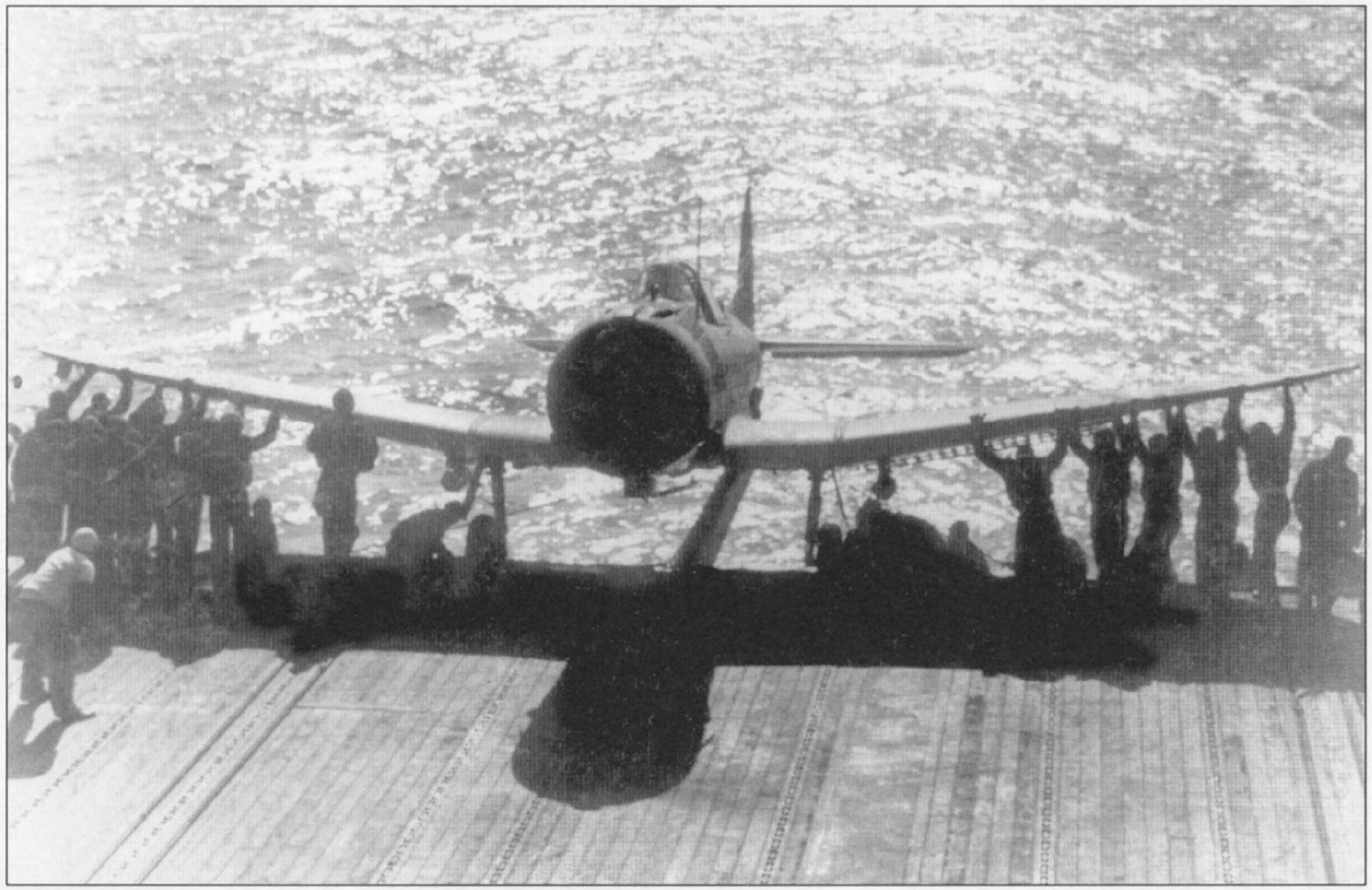
An effort was made to preserve *Enterprise* as a war memorial, but sadly it failed, receiving no support from a Navy and a government busy with other things. Perhaps that inattention has since been regretted; four other World War II-era aircraft carriers have since been preserved as memorials, none with a record as distinguished as hers. (*Enterprise* received 20 battle stars for her service in the war, three more than any other ship in the fleet. She also received a Presidential Unit Citation and a Navy Unit Commendation, and was awarded a Royal Navy Admiralty Pennant, the only ship outside the Royal Navy to ever have been so honored.) Ironically, two of the preserved carriers bear the names of *Yorktowns* lost during the war, though both are *Essex*-class replacements. (They are *Yorktown* [CV 10] now at Charleston Harbor, South Carolina, and *Hornet* [CV 12] at Alameda, California.) The U.S. Navy did name the first of the new generation of nuclear aircraft carriers after *Enterprise* in 1961. This *Enterprise* (CVN 65) remains in service as of this writing in February 2007.

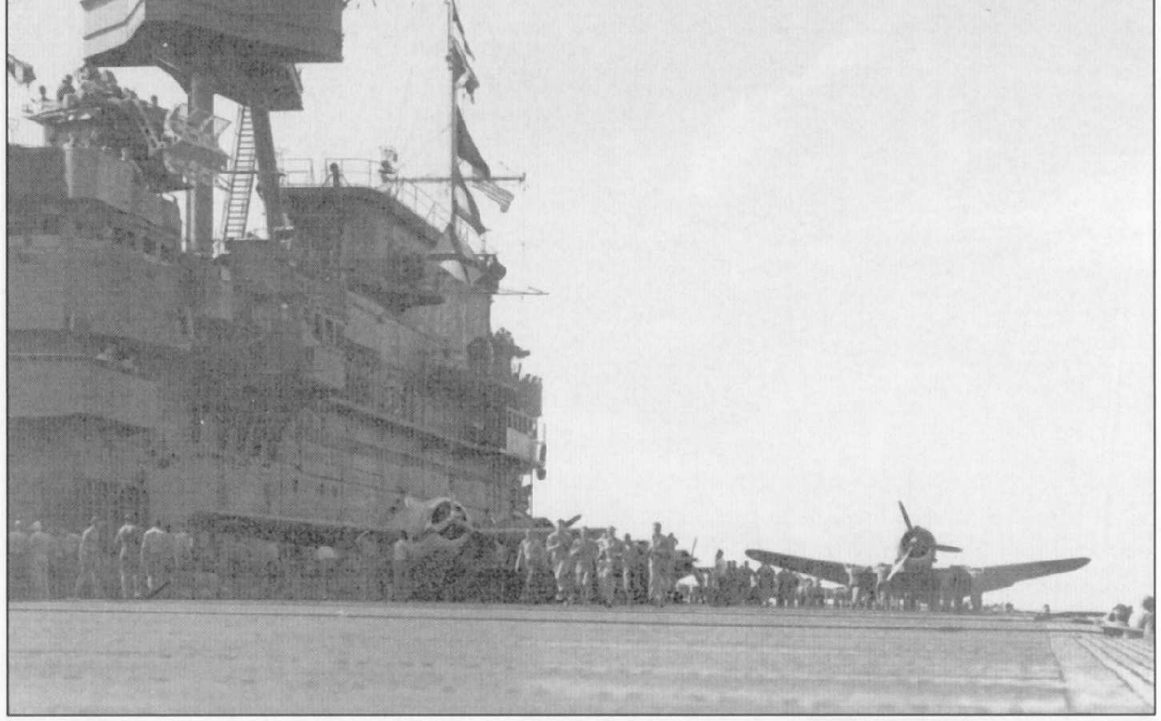


(Clockwise from upper left)
An SBD-2 is being moved to or from the hangar on one of *Enterprise*'s elevators, 24 February 1942, the day of the reprisal raid on Wake Island. As the three elevators were the same size, it's not possible to tell which elevator this is, but logic says it's most likely the midships elevator, as Dauntlesses would be stored in the middle of the hangar since they would be in the middle of a flight deck spot. The railing raised automatically on the flight deck whenever the hangar was lowered. *(NARA)*

Unlike cross-deck pendants (the official term for arrestor wires), which retracted automatically after use, the multiwire crash barriers had to be manually reseated in their grooves by crewmen. The numbers painted on the deck in white and black indicate the distance, in feet, to the ends of the flight deck (white to the bow, black to the stern). The trough of an outrigger extends from the flight deck to the left. *(NARA)*

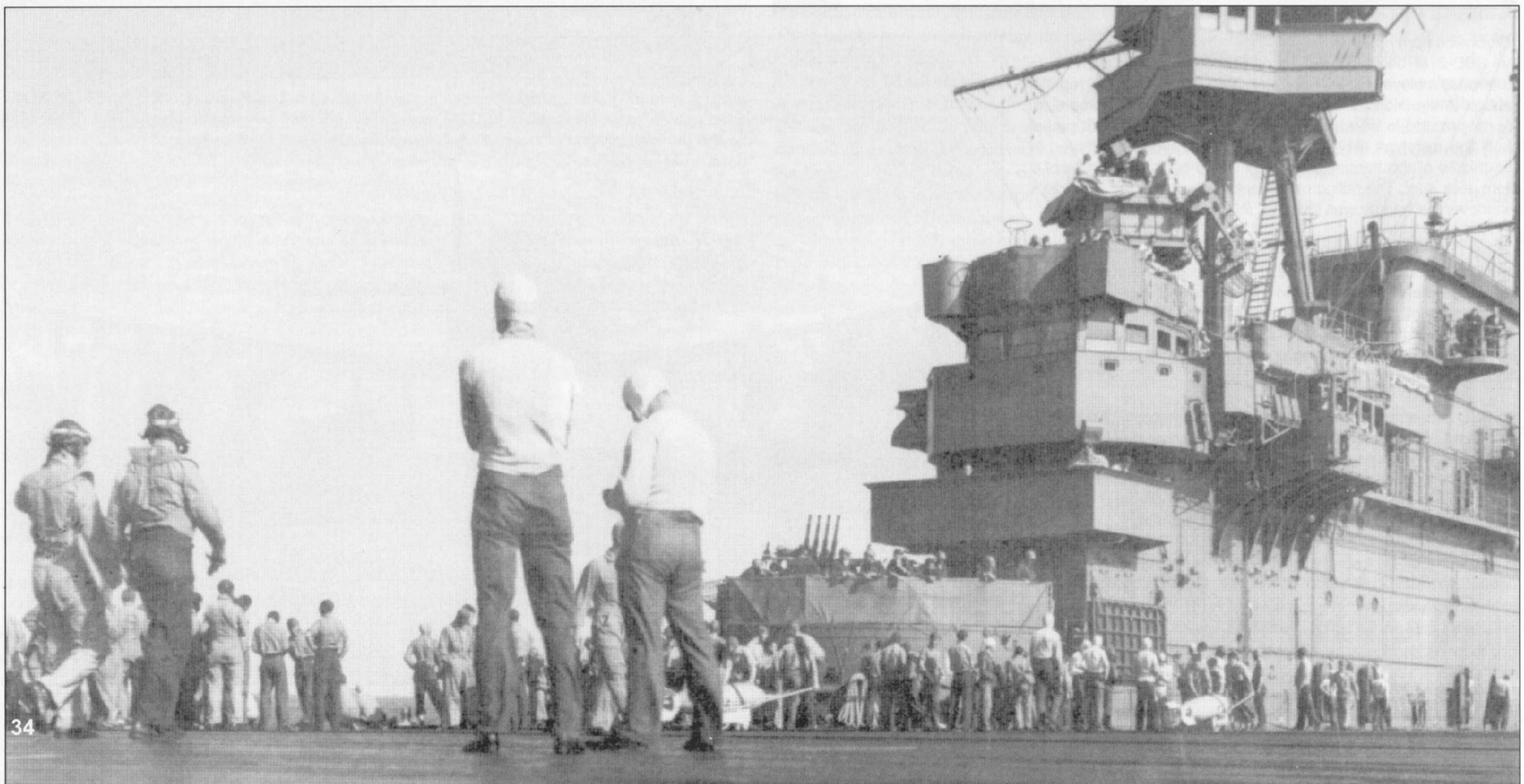
An SBD is pushed onto an outrigger by brute force, 17 April 1942. Motorized aircraft tractors didn't become common on U.S. aircraft carriers until midwar. Outriggers were a clever solution to the problem of what to do with spare aircraft on a crowded flight deck, but restricted the arcs of fire of defensive weapons and were not repeated on the larger *Essex*-class carriers. *(NARA)*





(Right) By the time *Enterprise* returned to the South Pacific after Midway, she now has FD (Mk 4) fire control radars fitted to her two Mk 33 directors. Here an SBD is being pushed aft in preparation for strikes in support of Operation Watchtower, the invasion of Guadalcanal, 7 August 1942. A semi-enclosed secondary air control station was added at the aft end of the island, probably just before the war. The long catwalk between that station and Pri-Fly farther forward was known as "Vulture's Row," as it would get crowded with spectators who seemed to take perverse pleasure watching flight deck mishaps during flight operations. *(NARA)*

(Below) Enterprise's bridge was simplified after Midway. The former navigation bridge level was reduced in size and enclosed behind splinter shielding with only a few small viewports along the upper edge. The roof of the pilot house was built up and became the forward air lookout station, in place of the foretop now occupied by the CXAM-1 antenna. While most of her AA mounts had thin steel splinter shielding, the number 2 1.1-inch mount in front of the island doesn't, making do with canvas stretched around the railing. *(NARA)*



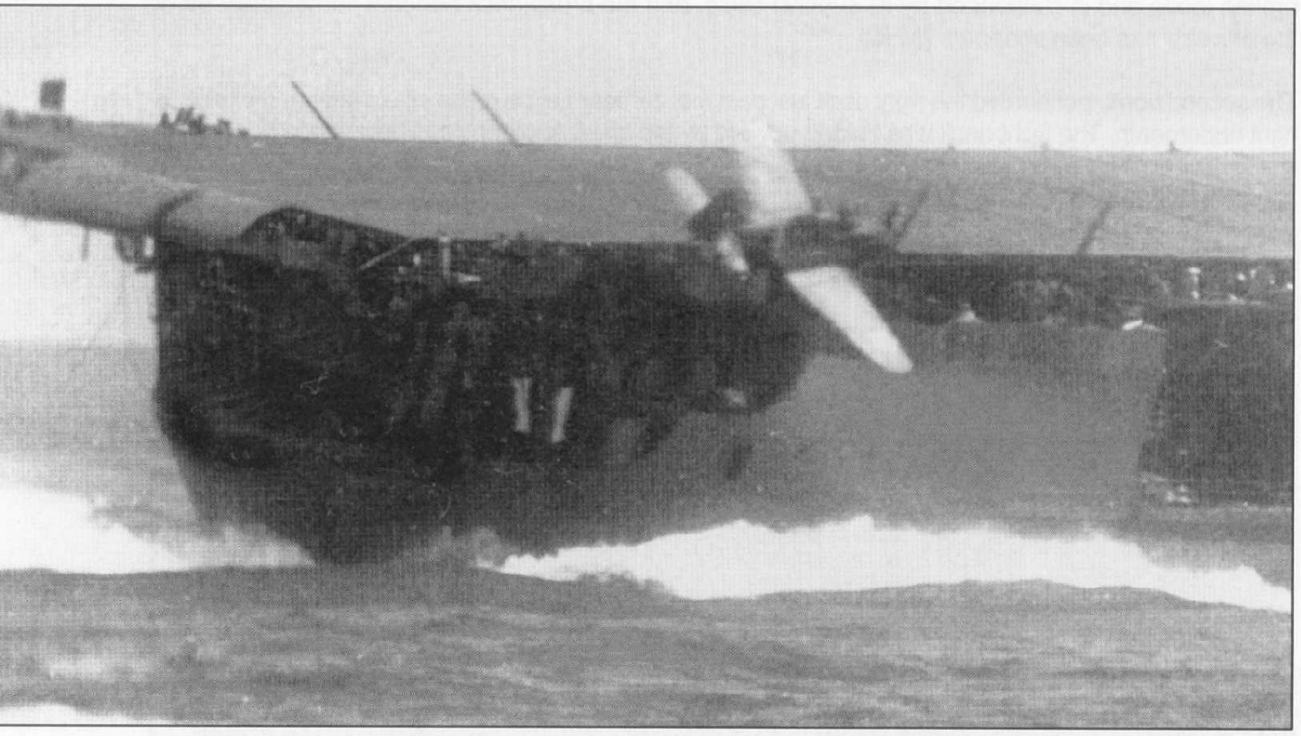
The third of three bombs to hit *Enterprise* at the Battle of the Eastern Solomons, 24 August 1942, exploded on contact with her flight deck, caught in this astonishing photograph. The view is looking aft from the island. Smoke seeps around the aft elevator, where the first two bombs hit just minutes earlier. *(NHC)*

Repair crews start working on the damage from the third bomb, right aft of the midships elevator. The torpedo elevator is to the left. Among other obvious "collateral" damage, the outrigger to the left has broken loose and is suspended by its support cable, and the cross-deck pendant immediately aft of the elevator has been snapped. *(NHC)*

Back at Pearl Harbor for repairs, 11 September 1942, crews stand on the bulge in the hangar deck caused by the first bomb that exploded between the second and third decks, forcing the hangar deck upward. The rolling steel shutters at the openings in the side of the ship are almost completely raised. *(NARA)*

The second bomb penetrated the flight deck just past the starboard edge of the aft elevator and exploded right underneath. The flight deck was bulged upward by the blast. Another side effect was a powder fire started in the ready ammunition for the 5-inch guns on that side. Crews douse the blaze with water from above the location, which rapidly brought the fire under control. *(NHC)*

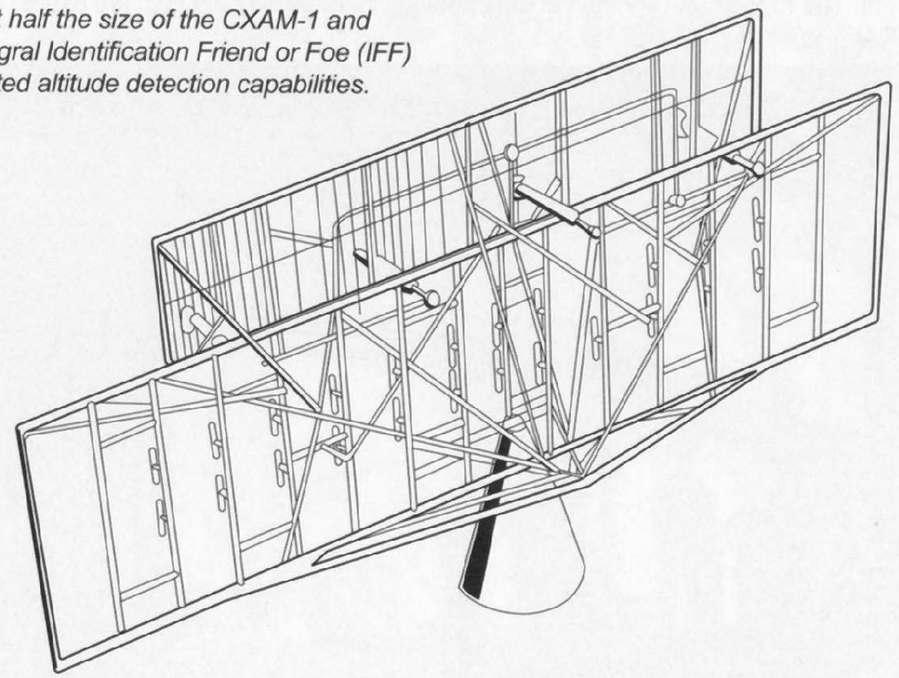
Just two days after *Enterprise* returned to the South Pacific, she was back in action again in the Battle of Santa Cruz, 26 October 1942. Shown above, a bomb explodes off her port side. This particular bomb caused no damage, but two other near-misses and two hits drove *Enterprise* back to port again for more repairs. Her four 40 mm mounts and those carried on the nearby battleship *South Dakota* (BB 57), helped prevent worse damage. *Hornet* did not fare as well as *Enterprise* at the Battle of Santa Cruz, as *Hornet* capsized and sank. *(NARA)*



During *Enterprise*'s rather violent maneuvers to avoid numerous torpedoes, this SBD was pitched into the starboard gallery just aft of number 7 5-inch mount. Four single 20 mm mounts can be seen at the round-down of her flight deck. These were added during her yard period after Midway. *(NARA)*

SC-2 Antenna

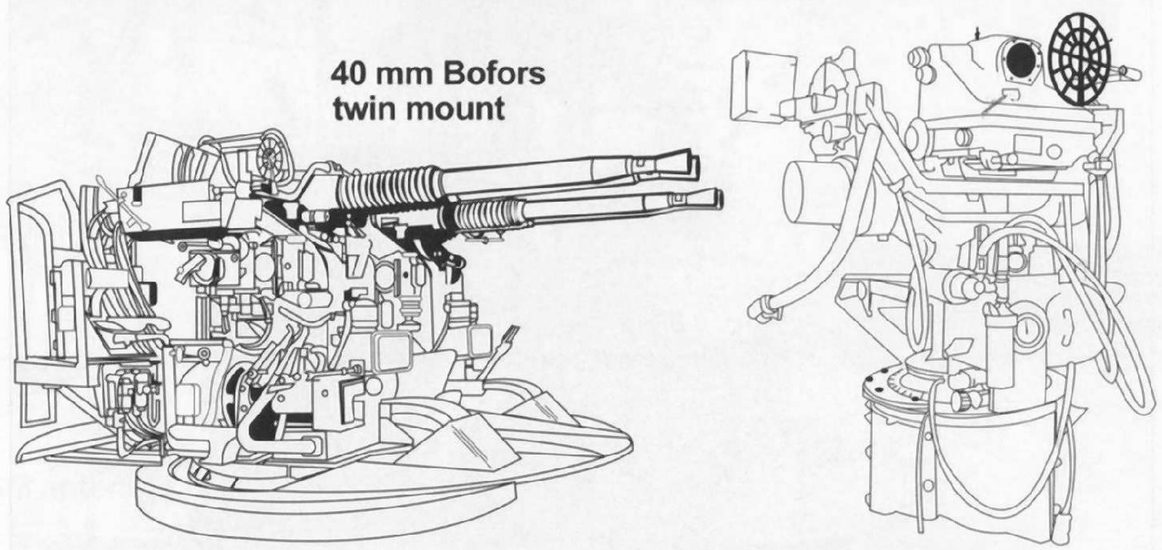
SC-2 was about half the size of the CXAM-1 and included an integral Identification Friend or Foe (IFF) system and limited altitude detection capabilities.



(Above) After her first major refit, *Enterprise* emerged with updated electronics and a strengthened AA fit, as seen 11 December 1943. She now had an SK antenna in the place of the CXAM-1 at the front of her foretop and an SM height-finder at the after end. She now had an SC-2 on the outrigger mast outboard of her funnel, replacing the SC-1 placed there in October 1942. Mk 37 directors have replaced the Mk 33s on her island. But the most important change is perhaps the least obvious — the stability blister added along most of her hull. The forward edge of the bulge can be seen just below the indent in her hull for the forward hangar deck opening; the after edge is below the aftmost 5-inch gun emplacement. Her degaussing cables have been removed, and an external aviation fuel line runs along her hull almost exactly where the cables had been. She is now painted in Ms 21, overall Navy Blue (5-N). *(NARA)*

(Bottom right) Nine of her now 14 40 mm mounts can be seen in this photograph, taken from off her port bow by one of *Enterprise*'s aircraft as she was en route to the Marshalls, 27 January 1944. Four of those mounts, including the two visible at the forward end of her island, were fitted in October 1942, the rest during her long late-1943 refit. These include five twin mounts visible at her bow and on both sides of her flight deck forward and two quad mounts in her portside aft boat pocket. The large numeral "6" is painted in black on her freshly stained Deck Blue (20-B) flight deck. A similar numeral was painted at the aft end of her flight deck. *(NARA)*

40mm Quad, Mk 51 Director



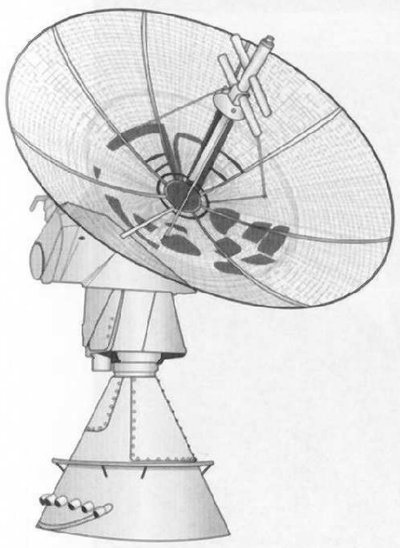
(Clockwise from right)
Alone among the U.S. Navy's operational fleet carriers to survive to midwar — not counting *Ranger* that had been reduced to a training role by this time — *Enterprise* never carried twin 5-inch turrets, allowing her to be distinguished from the *Essex*-class carriers she superficially resembled. Like them, by the time she is seen here at Palau in March 1944, she literally bristles with anti-aircraft guns and radar antennas. Her Ms 21 camouflage blends reasonably well with the background — this scheme was designed to be effective against observation from the air — except for the prominent wave caused by her new bulge. *(NARA)*

Compare this photograph to the bottom photograph on page 34 to see the changes made to *Enterprise*'s bridge during her late-1943 refit. The flag bridge has been deleted — it being unlikely she would ever host an admiral again — and both her navigation bridge and pilot house were rebuilt with a rounded front. A Mk 37 director has replaced the much larger Mk 33. The foretop is largely unchanged except that it has more large loudspeakers to better cover the flight deck. The Pri-Fly position just aft and inboard of the pilothouse has been much reduced in size and given a second, open upper level. *(NARA)*

This view from off *Enterprise*'s port quarter, also taken in March 1944, shows all her new radars. The SC-2 on its outrigger can just be made out behind the mainmast. She has an SG surface search antenna on top of her foremast and a second SG and what appears to be a YG radio beacon on top of her mainmast. Just to the right of the big aircraft crane, a twin 40 mm mount has been added in the superfiring position aft of the island. The aircraft on the flight deck aft is an F6F Hellcat. *(NARA)*

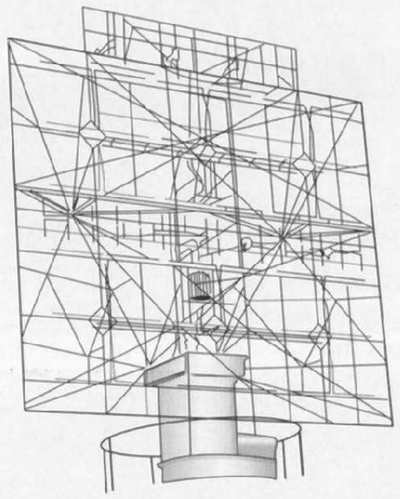
(Above and below) Enterprise, as seen from both sides, 31 October 1944. For a brief period of time that fall, she wore this splinter camouflage, Ms 33/4Ab, a light pattern using Navy Blue (5-N) as the darkest color. Some sources claim that she may have even used Dull Black on the dark panels, but this is unlikely. This camouflage was designed to protect against surface observation, as the biggest threat at this point was judged to be Japanese submarines. *(NARA)*

SK, SM Antennas



SM antenna

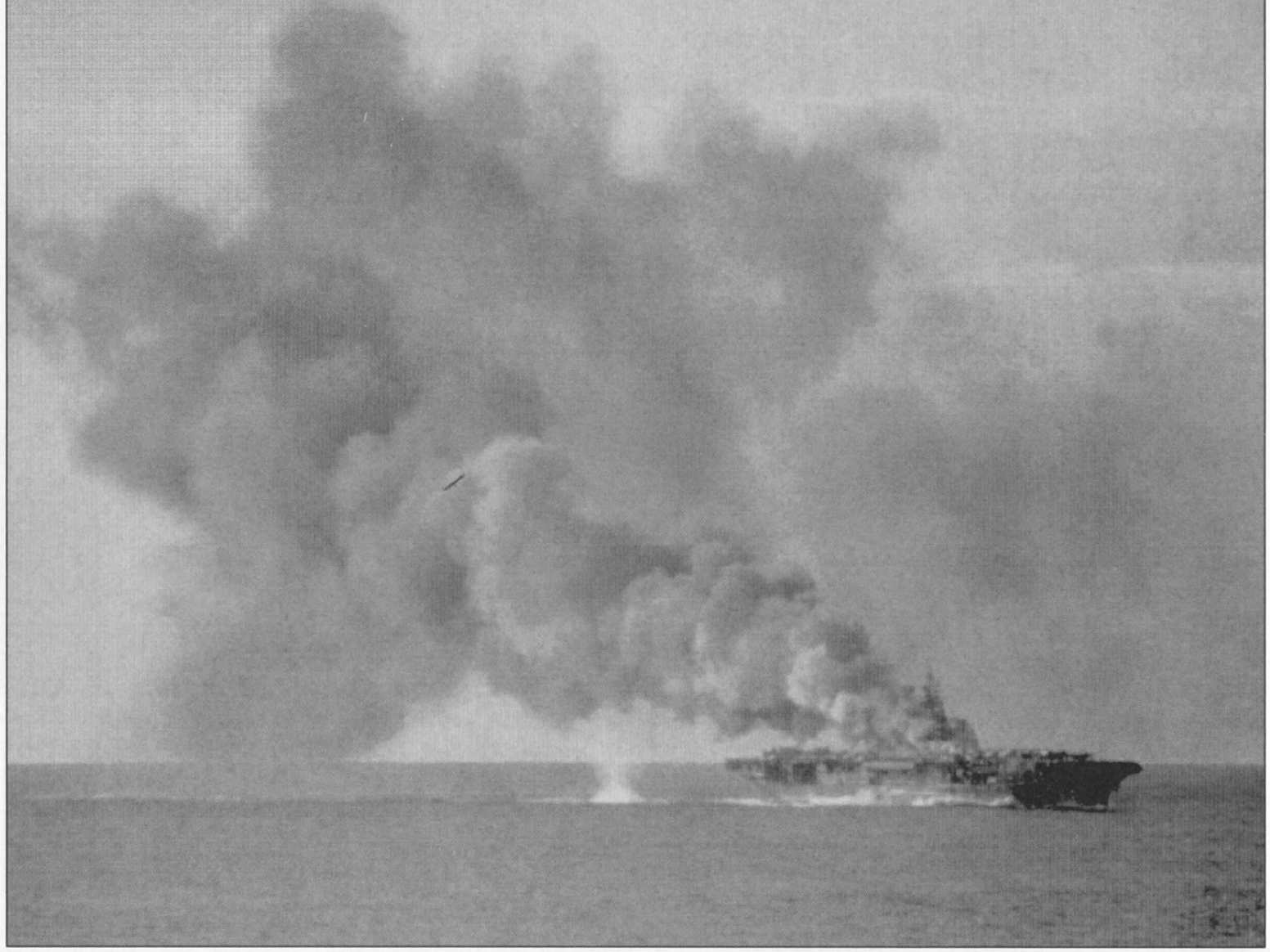
SK air search antenna

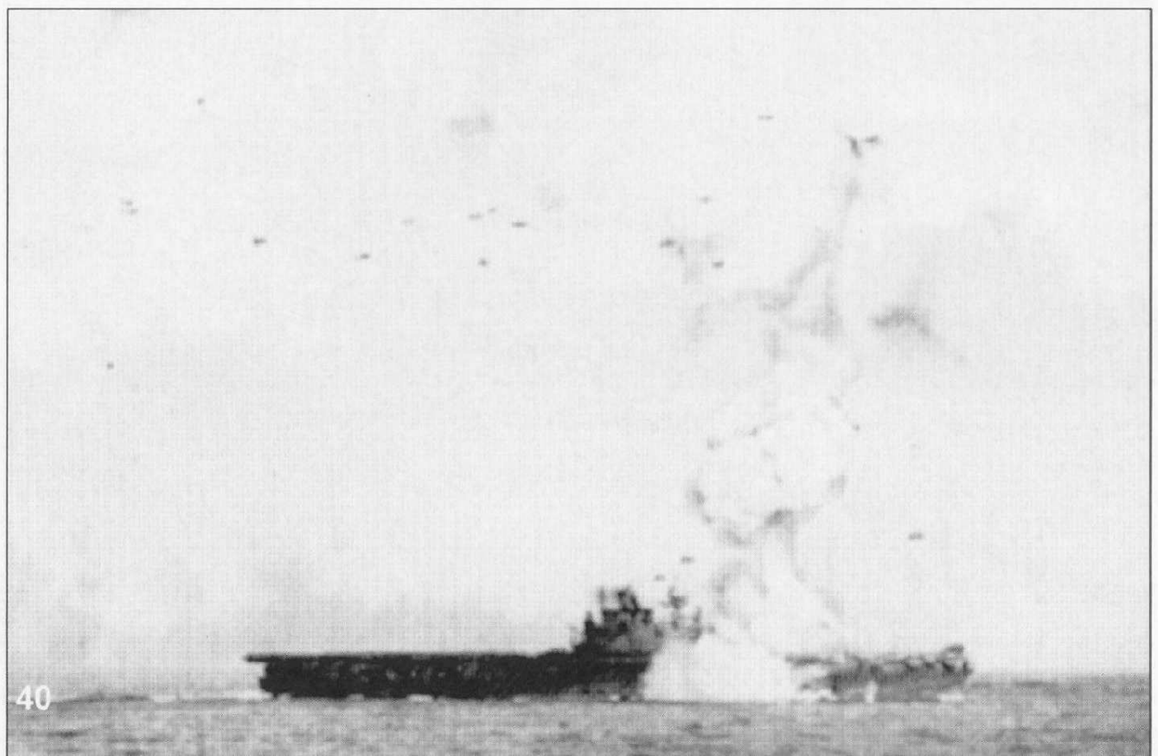


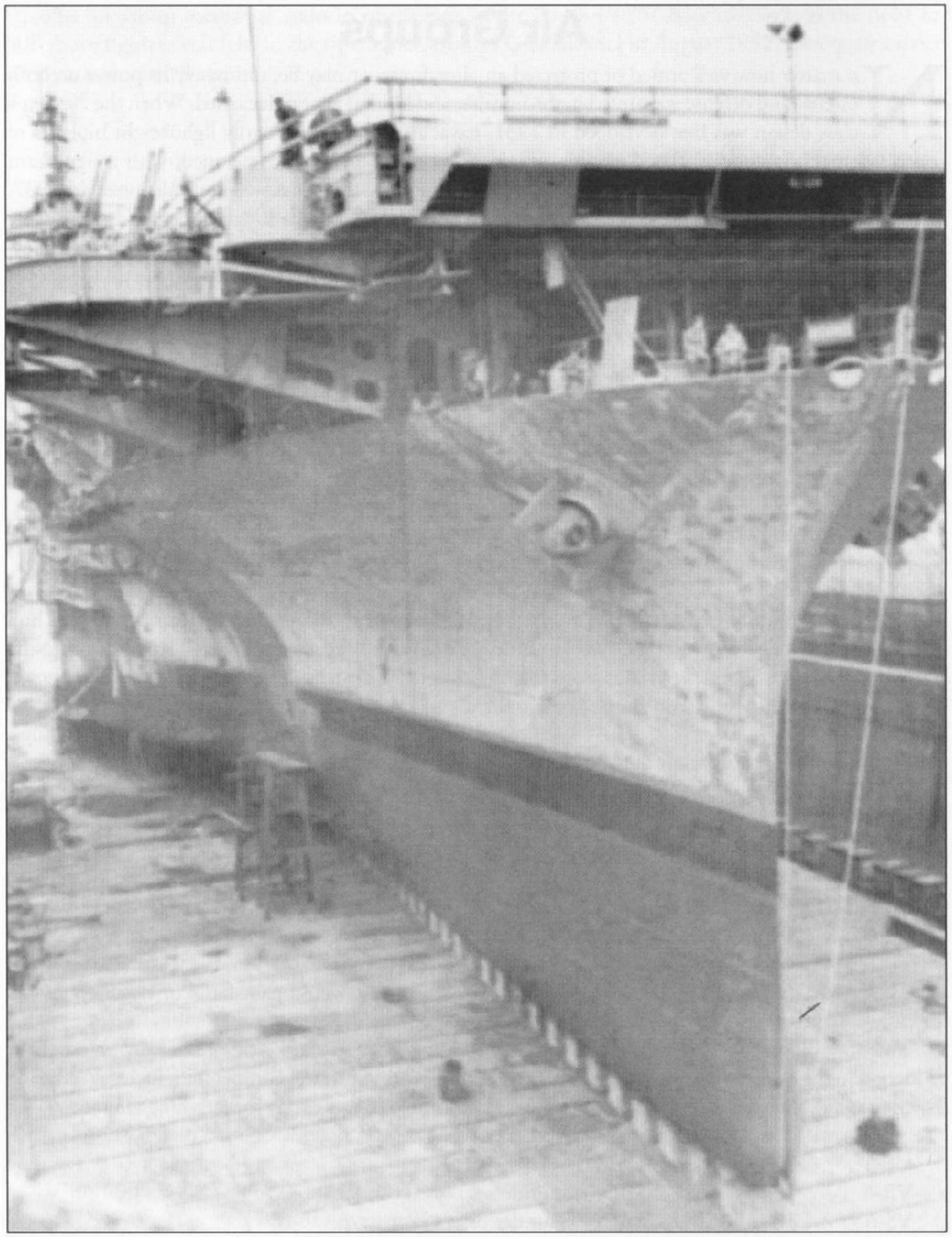
(Clockwise from top right)
Enterprise emerged from her late-1944 refit with a new role — night carrier — and an old camouflage, Ms 21, which was considered more effective against observation from above. In this view from *Hancock* (CV 19) on 20 March 1944, the splash of one bomb that near-missed is subsiding off her starboard quarter. However, the cause of the dense plume of smoke rising from her flight deck isn't enemy action. Aircraft were set ablaze by "friendly fire" setting off fires on the flight deck that drove *Enterprise* out of action for several weeks. The photo on the bottom left also shows the result of closely packed aircraft when exposed to enemy or friendly fire. *(NARA)*

Few sights are scarier on a flight deck than closely packed aircraft on fire. Crewmen fight just such a fire amid the fueled and armed F6F Hellcats of VF(N)-90 on *Enterprise*, 20 March 1945. *(NARA)*

Enterprise was finally driven from the war by a kamikaze that dove through her flight deck forward and exploded just under her forward elevator, sending part of that platform approximately 700 feet in the air, 14 May 1945. Again, the wisdom of her hangar design, with large openings through the ship's side, is seen as much of the blast vented outward, rather than downward or along the length of the hangar. She did not sink. *(NHC)*

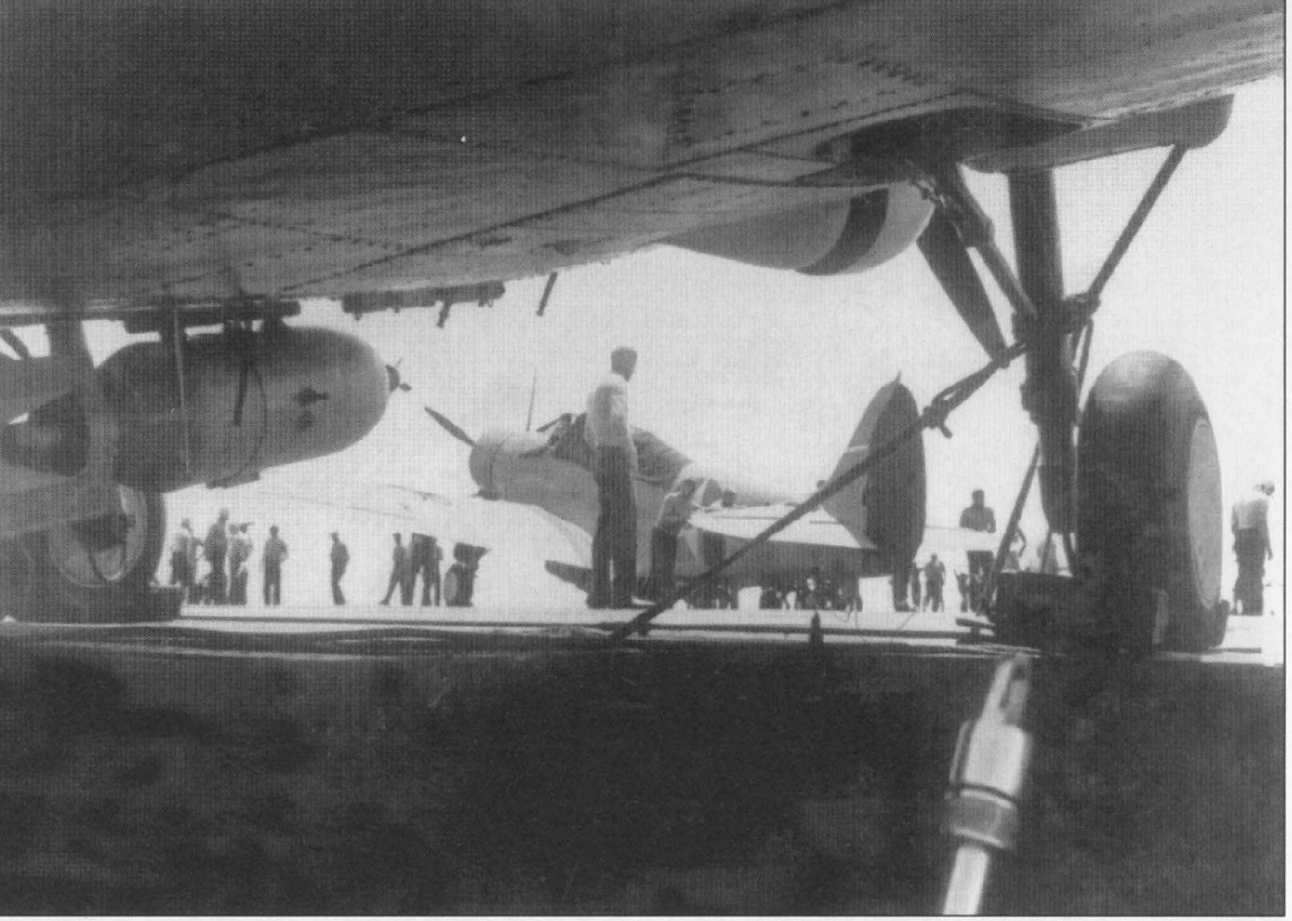






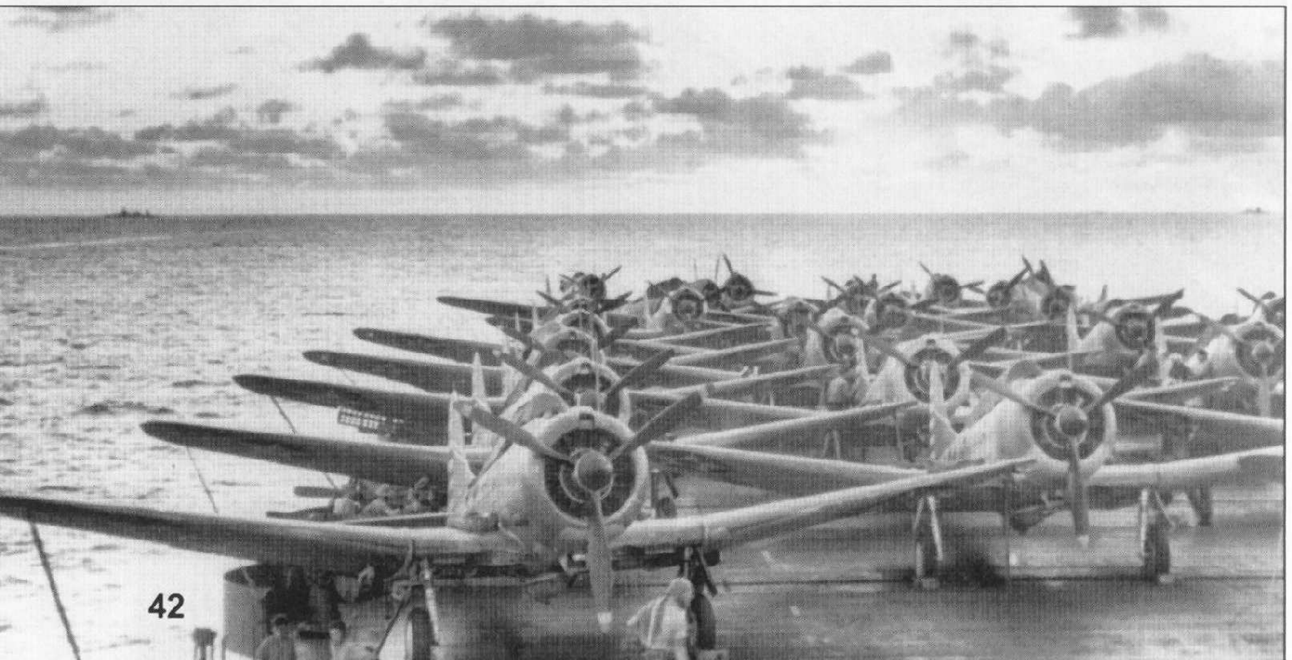
Enterprise is seen in dry dock at Bremerton, June-July 1945. As part of the refit following her damage off Okinawa, the 40 mm twin mount at her bow was removed, but the replacement of the twin mounts forward on both sides of the flight deck by quad mounts more than made up for any resulting loss in firepower. This shows some details of her hull very well, particularly the prominent bulge added in late 1943. The dark band at her waterline is black boot topping. Under that is red anti-fouling compound. *(via cv6.org)*

After spending Navy Day 1945 at New York City, *Enterprise* was modified to accommodate numerous returning soldiers, and she made four "Magic Carpet" runs from Europe to the United States before being retired. Her hangar deck, where once Dauntlesses and Wildcats had been serviced that had held the line in the darkest of days, was now full of GIs who, having done their part to serve that same cause, just wanted to get home and get on with their lives. *(NARA)*



A Dauntless in the foreground, armed with a small, probably 250-pound bomb and ready to be sent on a scouting mission, is tied down at the edge of the flight deck, her tail wheel (out of the frame to the left) resting in one of 11 outriggers. On the flight deck itself, seen between the wheels of the SBD, is a TBD-1 Devastator, with canvas covers over her canopy and rudder, in an attempt to make the ship less visible from the air. This photo was taken from the deck edge gallery across *Enterprise*'s flight deck, April 1942. *(NARA)*

The workhorse of the early-war CVG was the SBD Dauntless, a deck-load of which are seen on *Enterprise* in the Coral Sea, April 1942. This aircraft was used for scouting and dive bombing and, on more than one occasion, to fly CAP in the early days before the number of fighters in the air group was increased. *(NASM)*



Air Groups

No matter how well armed or protected an aircraft carrier may be, ultimately its power on both offense and defense is counted in the number and kind of aircraft it carried. When the *Yorktown* class design was first developed in 1931, naval aircraft were primarily lightweight biplanes of relatively small dimensions. Based on this, an air group of 90 aircraft was planned, with a significant reserve of additional aircraft stored in the hangar. By the time *Yorktown* was commissioned in 1937, aircraft were in the midst of a process of growth in size and weight, as longer range and speed were being demanded and all-metal single-wing designs replaced the fabric-covered biplanes of just a few years earlier. Nevertheless, *Enterprise*'s first air group approached 100 aircraft, including six utility aircraft (SU-3s), but this number is somewhat deceptive, as the bombing unit, Bombing Squadron (VB)-8B, was in the process of transitioning to the newer BT-1 and had more than double its authorized number of aircraft on strength. Of these aircraft, only the BT-1 was a monoplane, the rest biplanes. For the most part, these aircraft were all metal but were not much bigger than the aircraft that the *Yorktowns* were designed to operate.

VF-8B	18	F3F-2 (Fighting Squadron)
VB-8B	37	BT-1/SBC-4 (Bombing Squadron)
VS-8B	18	SBC-4 (Scouting Squadron)
VT-8B	18	BM-1 (Torpedo Squadron)

The squadron numbers were changed on 1 July 1937 so that squadron designators matched the hull number of the carrier to which they were assigned. Thus VF-8B became VF-6 and so on. During the prewar period, the assignment of squadrons to a ship was relatively permanent, so this group was known collectively as the Enterprise Air Group (Enterprise CVG).

By the time the war began, the composition of the air group had changed completely. CVG-6 on 7 December 1941 had 72 aircraft.

VF-6	18	F4F-3 Wildcats
VB-6	18	SBD-2 Dauntlesses
VS-6	18	SBD-2 Dauntlesses
VT-6	18	TBD-1 Devastators

These were the Wildcats, Dauntlesses, and Devastators that would gain fame or notoriety as the aircraft that fought and won the early battles of the Pacific war.

The only difference in the air group that flew off *Enterprise* at the Battle of Midway was a slight reduction in the number of torpedo aircraft and significant increase in the number of fighters, as early war experience had shown the need for both increased CAP and stronger escort for attacking aircraft.

VF-6	27	F4F-4 Wildcats
VB-6	18	SBD-2/SBD-3 Dauntlesses
VS-6	18	SBD-2/SBD-3 Dauntlesses
VT-6	14	TBD-1 Devastators

The large hangar of the *Yorktowns* allowed them to accommodate an increase to 77 aircraft, though this number definitely crowded the flight deck and made aircraft spotting more difficult.

The air group increased again in operations in the South Pacific later in 1942, as the need for still more fighters was felt. In the operations around Guadalcanal in August 1942, *Enterprise* carried 87 operational aircraft.

VF-6	36	F4F-4 Wildcats
VB-6	18	SBD-3 Dauntlesses
VS-6	18	SBD-3 Dauntlesses
VT-3	15	TBF-1 Avengers

After Midway, where the U.S. Navy's torpedo squadrons had been decimated, *Enterprise*'s air group "borrowed" *Saratoga*'s torpedo squadron, which had been working up the new Grumman Avenger while that carrier was being repaired. This was the beginning of a gradual process of disassociating air groups from carriers that would inevitably occur as the numbers of both increased dramatically as the war progressed. After the Battle of the Eastern Solomons, CVG-6 was replaced by CVG-10, with the same numbers and types of aircraft.

Emerging from her mid-1943 refit, *Enterprise* carried a similar air group, totaling 91 aircraft.

VF-2	36	F6F-3 Hellcats
VB-6	37	SBD-3/SBD-5 Dauntlesses
VT-6	18	TBF-1 Avengers

The most notable change was the absorption of the scouting squadron into the bombing squadron. From the mid-1930s, the role of the scouting squadron had been increasingly difficult to distinguish from their bombing counterparts, especially as they were most often equipped with the same aircraft. The other significant change was the replacement of the obsolescent Wildcats with the far superior Hellcats equipping the fighter squadron.

In January 1944, CVG-10 again replaced CVG-6. This air group differed only in having, in addition to the Dauntlesses, Hellcats, and Avengers, four night fighters, F4U-2(N) Corsairs. In August, CVG-20 replaced CVG-10, with a somewhat different set of aircraft.

VF-20	32	F6F-5 Hellcats
VF(N)-78	4	F6F-3(N) Hellcats
VB-20	20	SB2C-3 Helldivers
VT-20	16	TBM-1C Avengers

The night fighters this time were Hellcats, easier to handle than the Corsairs, and the dive bombers were the troublesome Curtiss Helldivers. This time the air group was again smaller, just 72 aircraft, as the Helldivers were significantly bigger than the Dauntlesses they replaced.

When *Enterprise* was designated a night aircraft carrier late in the year, her air group was now CVG(N)-90, totaling just 55 aircraft.

VF(N)-90	34	F6F-5(N) Hellcats
VT(N)-90	21	TBM-3D Avengers

The philosophy behind marking the national insignia on U.S. Navy aircraft in the Pacific went through several distinct changes in the early months of the war. At one point, in May 1942, it didn't seem possible to have too many roundels or to make them too large, as on these Dauntlesses on *Enterprise*, 3 May 1942. *(NARA)*

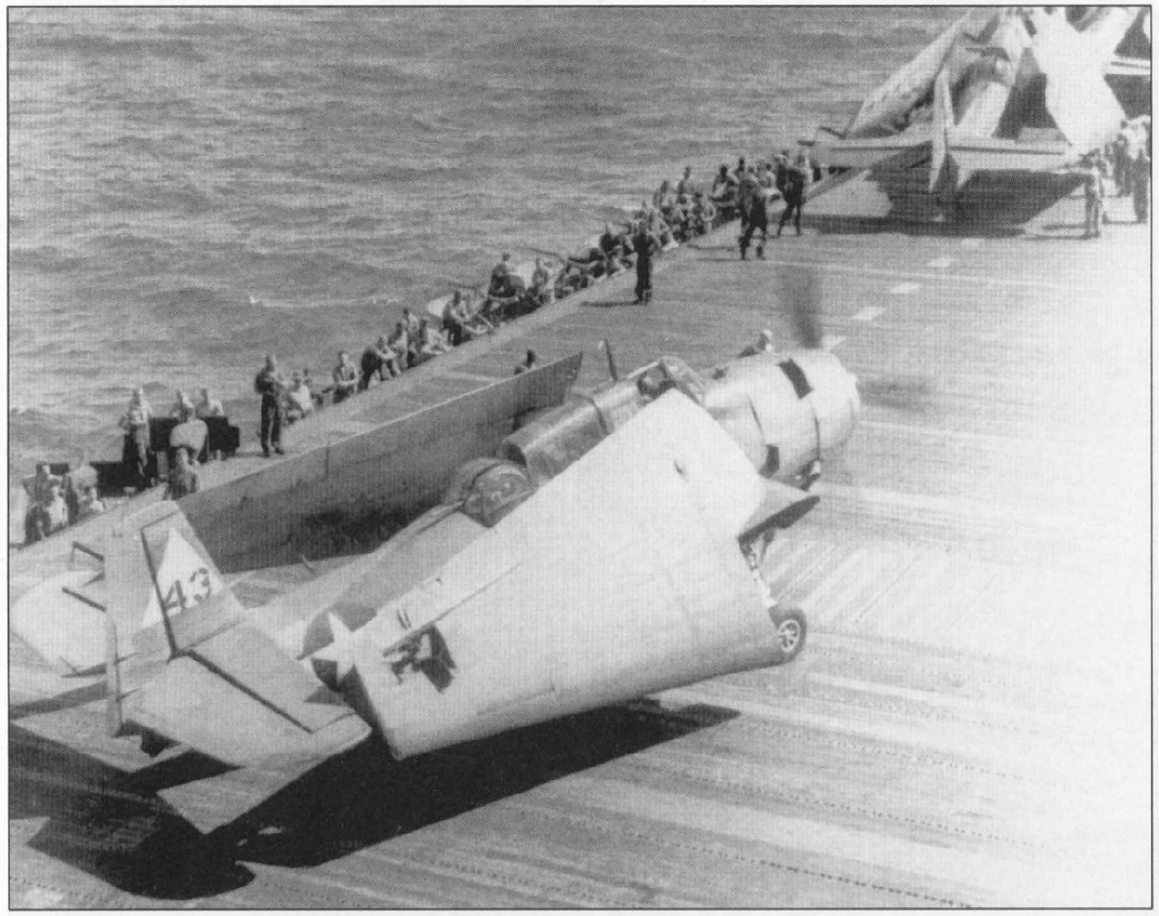
The F4F Wildcat was big and slow compared to the Zero, which could fly circles around it. But the F4F was strong and well armed, capable of absorbing much more punishment than the lighter-built Japanese fighter. The Wildcat was popular with U.S. pilots, especially after better tactics, such as the Thach Weave (fighting in pairs, using a weaving tactic), were introduced that compensated for some of the Wildcat's weaknesses. This photo was taken aboard *Enterprise* in April 1942. *(NARA)*

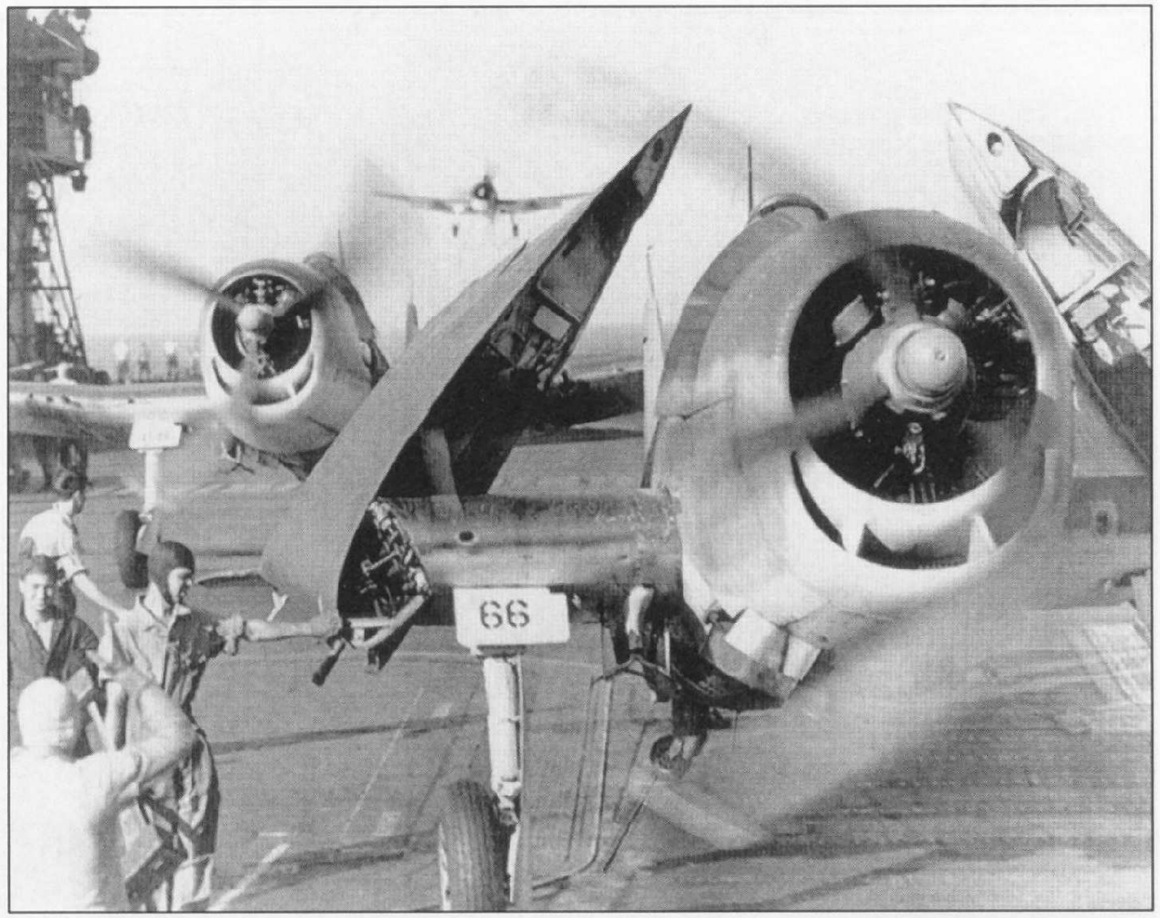
The crews on the *Yorktowns* kept the aircraft in the air. Each task on the flight deck was designated by a color of cap, so that each man's duty could be instantly identified. Plane handlers move quickly to unhook the arrestor wire after a Wildcat traps on *Enterprise*, 15 May 1942. They wear blue caps. *(NARA)*

A pair of plane handlers, in blue caps, help the pilot of this Dauntless on *Enterprise* strap in to the cockpit premission, 31 May 1942. A red-capped fuel handler climbs up from the left with his hose to top off the plane's tanks. *(NARA)*

Yellow-capped ordnancemen prepare to sling a 500-pound bomb under a Dauntless. This involved attaching the bomb to the aircraft's "crutch," which would sling the bomb down and away from the aircraft's belly, thus clearing the propeller, and attaching the "safing" wire to the aircraft. This allowed the bomb to arm only after it was dropped. *(NHC)*

The Landing Signal Officer (LSO) on *Enterprise* signals a pilot that he's low — below the proper glide slope — and needs to get his nose up, 31 May 1942. The platform he's on extends out over the portside gallery right aft. The white canvas backdrop was added when pilots complained they couldn't see the paddles well enough against the confusing background of the gallery and flight deck. *(NARA)*

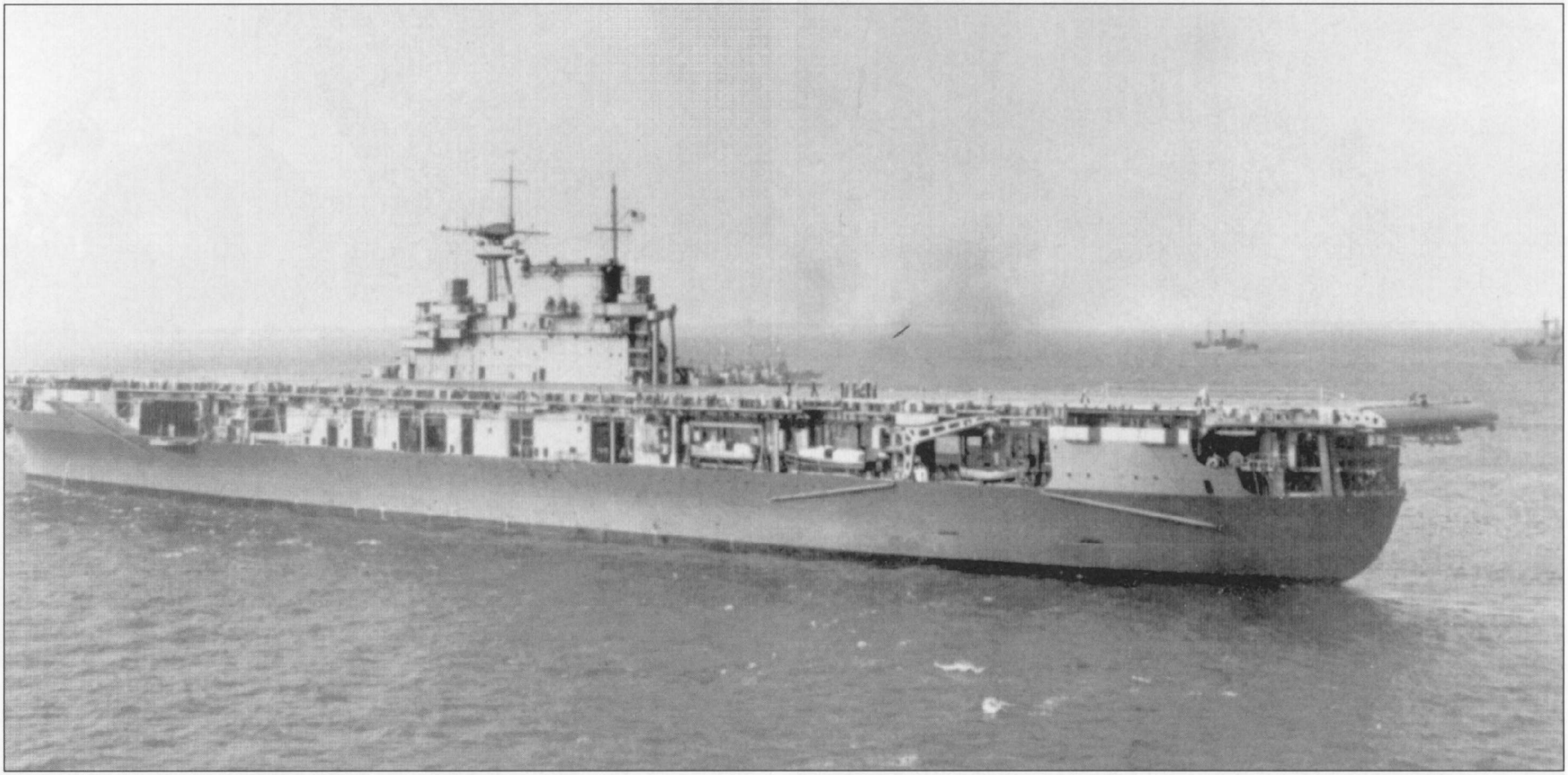




(Clockwise from upper left)
Later in the war, new and bigger aircraft replaced the first generation of wartime aircraft. The first of the newer models was the TBF/TBM Avenger, which replaced the Devastator as the standard torpedo bomber. The Avenger was popular because it was significantly faster than the Devastator and could absorb tremendous punishment. Witness the hole blown in the wing of this TBM-1C of VT-20, seen on *Enterprise*, 25 October 1944. *(NARA)*

Similarly, F6F Hellcats replaced the Wildcat in fighter squadrons. A trio of F6F-5s of VF-20 are seen on *Enterprise* during the Truk raids, 17–18 February 1944. Two are taxiing forward on the deck, the one in the foreground with its wings already folding, as the third is landing. The sailor in the white cap at the left of this image is a plane captain, responsible for the movement of the aircraft under his control. *(NARA)*

Enterprise's final role was as a night carrier. This radar-equipped TBM-3D of VT(N)-90 is towed aft on her flight deck, March 1945. Tractors have replaced brute force as the means of moving aircraft. This Avenger has taken some damage to both wings and her prop, probably caused by an encounter with a crash barrier, and will be struck down to the hangar for repairs. Aircraft had become so plentiful by this time that this aircraft might just be pitched overboard if it were determined to be too difficult to repair. *(NARA)*



Seen during her working up, *Hornet* is still without her armament, late 1941. However, she already wears an Ms 12 paint scheme, the standard Atlantic camouflage for the early part of the war. She can be most easily distinguished from her sisters at this stage by her lighter foretop and the smaller Mk 37 directors fore and aft on her island. *(NARA)*

Hornet (CV 8)

The laying down of *Hornet* lagged five years behind that of her sisters. She was begun on 25 September 1939 at the same yard where *Yorktown* and *Enterprise* had been built. The urgency of the world situation caused her construction to proceed much faster, and she was launched on 14 December 1940 and commissioned into the Navy on 20 October 1941, just three years and five months after *Enterprise*. Her working up was accelerated, particularly after the attack on Pearl Harbor, and she left for the Pacific on 4 March 1942.

Externally, she was virtually indistinguishable from *Enterprise*. Her bridge had a somewhat different appearance, with a prominent freestanding armored conning tower in front of her open bridge structure. She had a somewhat smaller fighting top than her sisters. Most noticeably, she had Mk 37 directors in the place of the older, larger Mk 33s. As she was working up in the Atlantic, she was painted in the Ms 12 graded scheme that was standard for ships operating in that theater. During her final docking at Norfolk before departing for the war, she received a new scheme, an Ms 12 Mod "dapple" camouflage. This used the same three colors — Sea Blue (5-S), Ocean Gray (5-O), and Haze Gray (5-H) — as the standard Ms 12, but broke up the horizontal dividing line between the colors with a wavy edge and "splotches" of color. This was considered more effective in the Pacific, which was in general much sunnier and less foggy than the North Atlantic.

At the same time, *Hornet* had FD radars fitted to her Mk 37 directors. Either at this time, or at North Island (San Diego, California) in late March, she received a new SC air search radar. This used electronics upgraded from the older CXAM with a smaller antenna, which caused it to have reduced range. After Midway, *Hornet* received a CXAM antenna salvaged from the damaged battleship *California* (BB 44). The larger antenna combined with the SC's more powerful electronics gave the hybrid radar better performance than either the CXAM or the original SC. Her bridge contained a primitive version

of a Combat Information Center (CIC) from the beginning. *Hornet* received 20 mm mounts before leaving the Atlantic, a total of 30 by the time she fought at Midway. (She had 22 along the edge of the flight deck, two at the bow, two at the round-down of the flight deck right aft, and four alongside the island, where the boat crane had been. It appears that *Hornet* never carried .50-caliber machine guns.) She also had four 1.1-inch mounts at Midway, two at the front of her island, one on the flight deck immediately aft of the large aircraft crane aft of the island, and one in the starboard side flight deck gallery farther aft. After that battle, a fifth 1.1-inch quad mount replaced the two 20 mm mounts at her bow. By the time she left again for the South Pacific, her 20 mm battery had been increased to 32. (It is not certain where the four extra 20 mm mounts were placed — two new and two displaced from the bow — but it is likely they were sited alongside the island.) It was in this configuration that *Hornet* fought her last battle.

Operational History

Hornet was destined to have the shortest operational career of any U.S. aircraft carrier, but that did not prevent it from being extremely eventful. While still working up in the Atlantic, she had departed Norfolk on 2 February 1942 with a pair of USAAF B-25 bombers on deck. To the delight of her crew, both bombers were launched successfully later that day. The reason for this bizarre exercise was explained only after *Hornet* docked at San Francisco and embarked 16 of the Army bombers along with their crews. Once at sea, it was announced that the bombers, under the command of Lt. Col. James Doolittle, were to bomb Japan, and *Hornet*, joined by *Enterprise* near Midway, was to deliver them within range. The plan was to get within 400 miles of the target before launching, but they were sighted by a Japanese picket boat on 18 April while still some 600 miles from Japan. The decision was made to launch rather than abort the mission or put two of the Navy's precious aircraft carriers at risk. The raid was a stunning success, not for the material damage to their targets, which was minimal, but for the psychological impact on the Japanese, which was profound.

The two carriers returned to Pearl Harbor and left together for the South Pacific too late to take part in the Battle of the Coral Sea. Again with *Enterprise*, she then steamed at full speed back to Pearl Harbor and departed again on 28 May for Midway. She participated in that battle with her two sisters, but her part was less glorious as her dive bombing squadrons failed to find their targets that day. Her torpedo squadron, VT-8, attacked *Hiryu*; sadly, all 15 aircraft were shot down with only one crew member surviving.

Hornet spent the next month and a half in the waters around Pearl Harbor undergoing refit and working up a new air group. She left for the Southern Pacific on 17 August, arriving too late to take part in the Battle of the Eastern Solomons. Her late arrival was nonetheless fortuitous, as the damage to *Enterprise* and *Saratoga* and the sinking of *Wasp* left her the sole U.S. aircraft carrier in the area between 15 September and 24 October, when she was rejoined by *Enterprise* just in time for the Battle of Santa Cruz two days later.

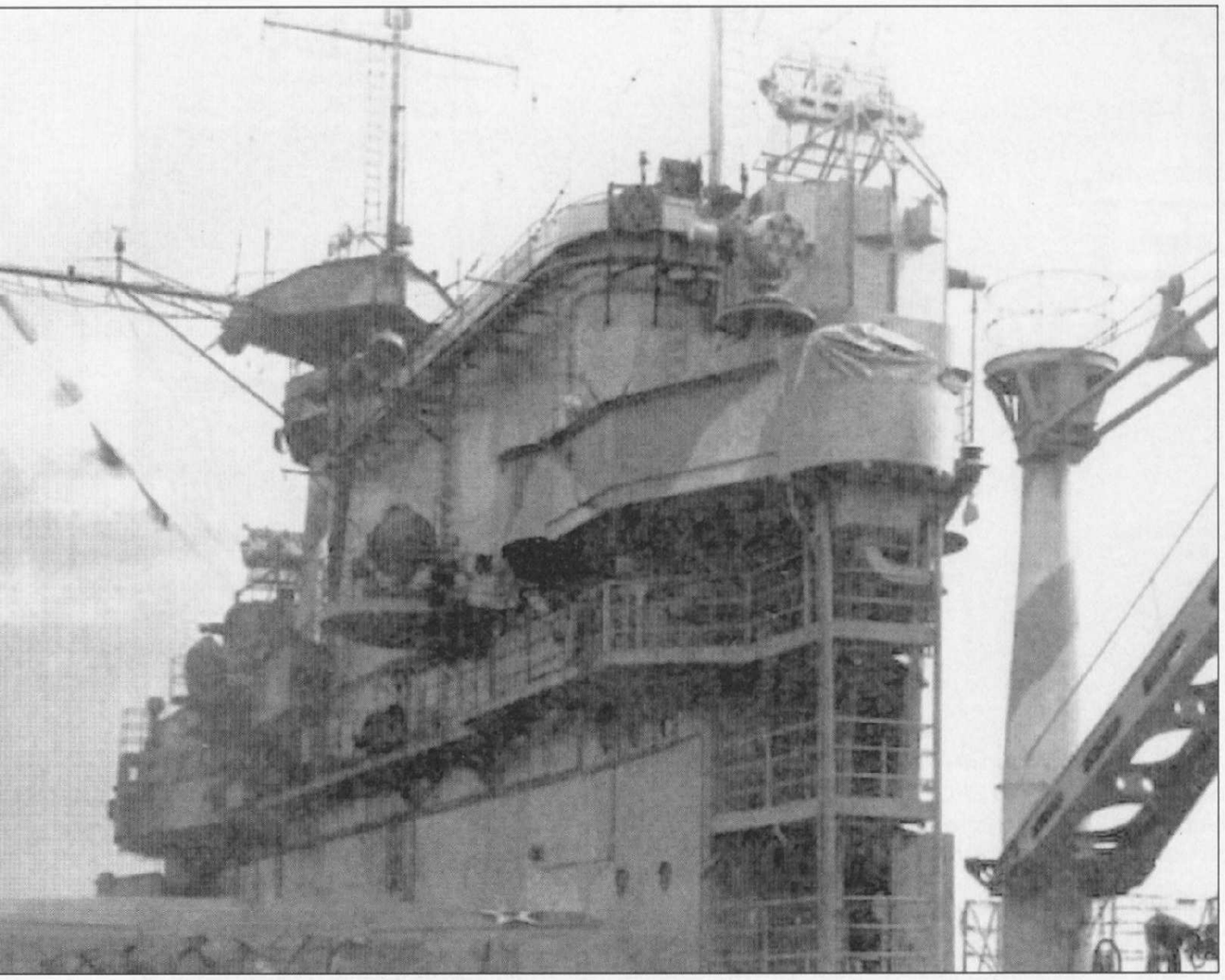
Another view of *Hornet* as she worked up, this one dated 27 October 1941. No radars have yet been fitted. Her bridge structure is different in many details from both of her sisters; in particular, the prominent cylindrical conning tower sets her apart. She has the small main battery rangefinder on her pilothouse, which was already scheduled for removal on her sisters by this time. *(NARA)*

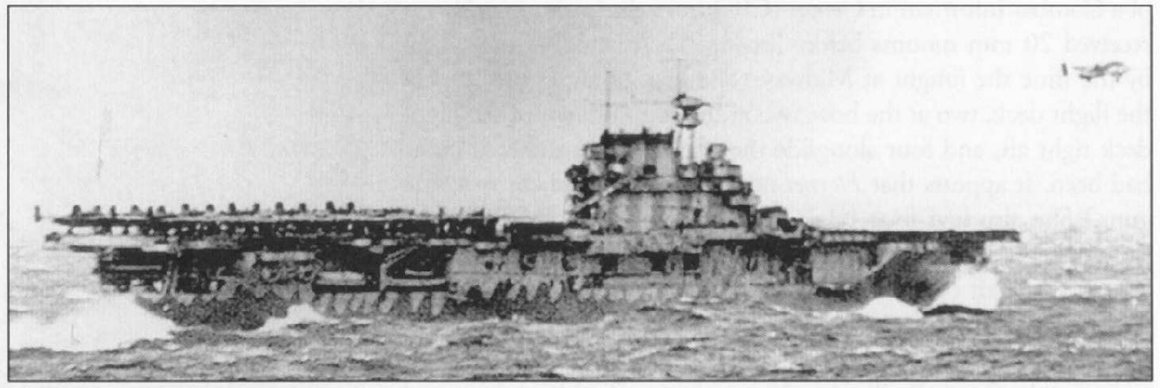
In this battle, *Hornet* was hit by three bombs during the initial attack and received another bomb hit when a Val was damaged during its dive and crashed into the forward edge of *Hornet*'s funnel. The bomb the Val was carrying continued on and exploded on her flight deck. Two torpedoes hit her starboard side, flooding the boiler rooms on that side and causing the loss of all power. One more Val crashed her deck forward, adding to the devastation. Yet, despite this damage, firefighting crews made good progress on the hangar deck, and the heavy cruiser *Northampton* (CL 26) got a tow line over to the carrier at about 1130 and started towing her south at 4 knots. In the meanwhile, 800 of her crew had been taken off, leaving only those actively engaged in damage control. For a brief moment, it looked as if *Hornet* might be saved. However, the tow line parted after just 10 minutes, and it wasn't until 1450 that she was again under tow.

Meanwhile, the Japanese had put together a scratch force of seven Kates and seven Zeros from *Zuikaku* and *Junyo*, which found *Hornet* at 1520. Two of the Kates were shot down, and two went after *Northampton* without success. The remaining three aimed their torpedoes at *Hornet*. Two of those missed, but the last one slammed into *Hornet*'s starboard side within feet of the first hit and effectively doomed any chance of rescuing the carrier.

Persistent Lady's Demise

With Japanese surface forces sweeping down from the north, Rear Adm. George D. Murray, task force commander, ordered *Hornet* abandoned and sunk. After the last of the crew was taken off, the destroyers *Mustin* (DD 413) and *Anderson* (DD 411) were left to finish off *Hornet* while the rest of force headed south. Between them they fired 16 torpedoes at *Hornet*, of which at least nine hit; but the carrier refused to sink. A total of 430 5-inch rounds fired at her waterline seemed to do little, and, finally, convinced they could do nothing more and concerned about enemy forces coming over the northern horizon in the gathering dusk, the two destroyers set off to the south at high speed. Thus, the Japanese found themselves in possession of a derelict and battered U.S. aircraft carrier. A quick examination convinced Rear Adm. Hiroaki Abe that they had no chance of salvaging her. At 0135 on 27 October 1942, *Hornet* was finished off by four big Type 93 torpedoes fired from the destroyers *Akigumo* and *Makigumo*.





(Clockwise from upper left)
Before leaving for the Pacific, *Hornet* stopped at the Norfolk Navy Yard, Virginia, for a final refit and a paint job, late February 1942. The refit added FD radars on her Mk 37 directors and an SC antenna on her foretop, which cannot be made out in this view. The aft Mk 37 director is a bit hard to make out because it is turned toward the funnel, exposing the less-often-seen rear of the apparatus. At the same time that she received these new electronics, *Hornet* was repainted in Ms 12 Mod camouflage, which used the same colors — Sea Blue (5-S), Ocean Gray (5-O), and Haze Gray (5-H) — as the standard Ms 12, but used a wavy dividing line and splotches of color to break up the silhouette. *(NARA)*

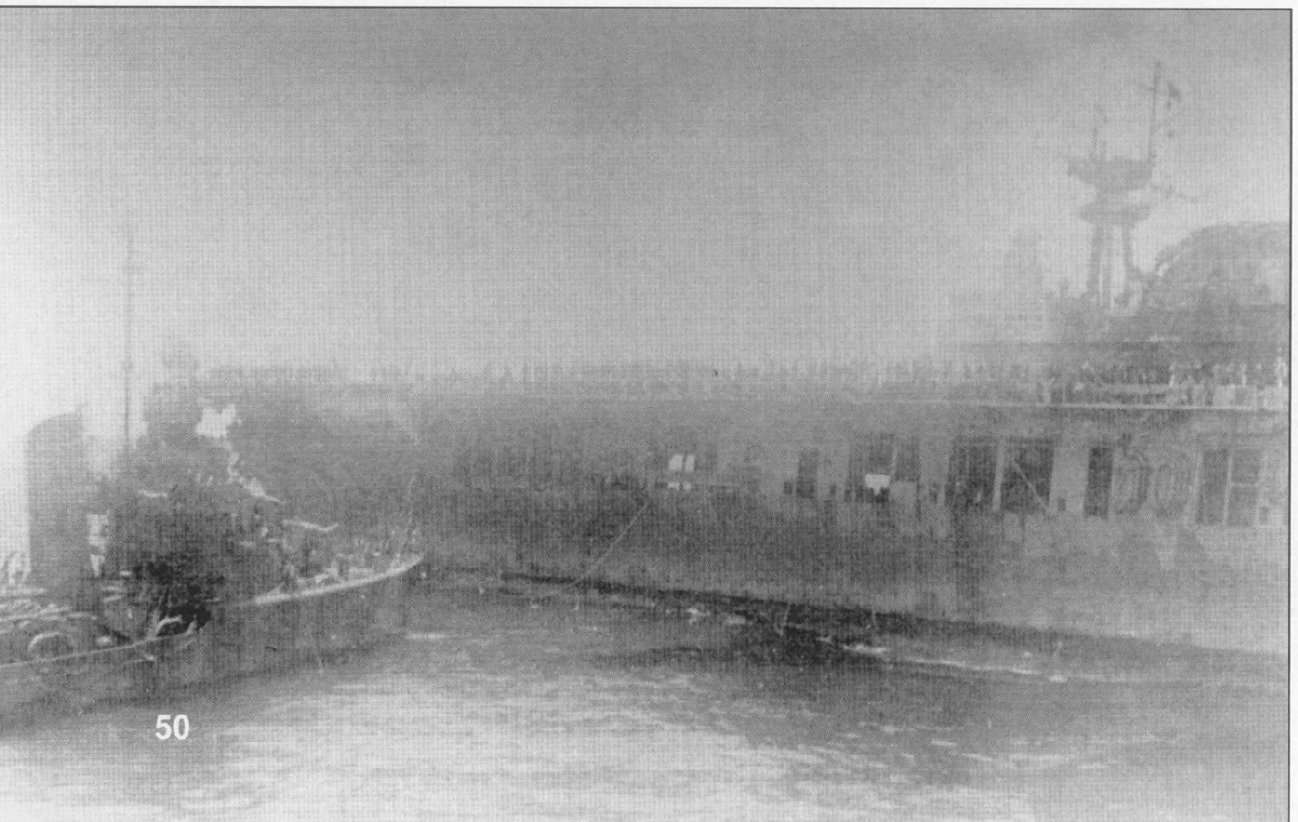
Even though *Hornet* fought at Midway and later at the Battle of Santa Cruz, she is most famous for carrying Lt. Col. Jimmy Doolittle's B-25 Mitchell bombers on their way to Tokyo. The bombers were launched 200 miles farther from Japan than planned, meaning none landed at their designated airports in China, but the raid was nevertheless a stunning success from a psychological point of view, 18 April 1942. Her main battery rangefinder has been removed. This was probably done at Norfolk in February. *(NARA)*

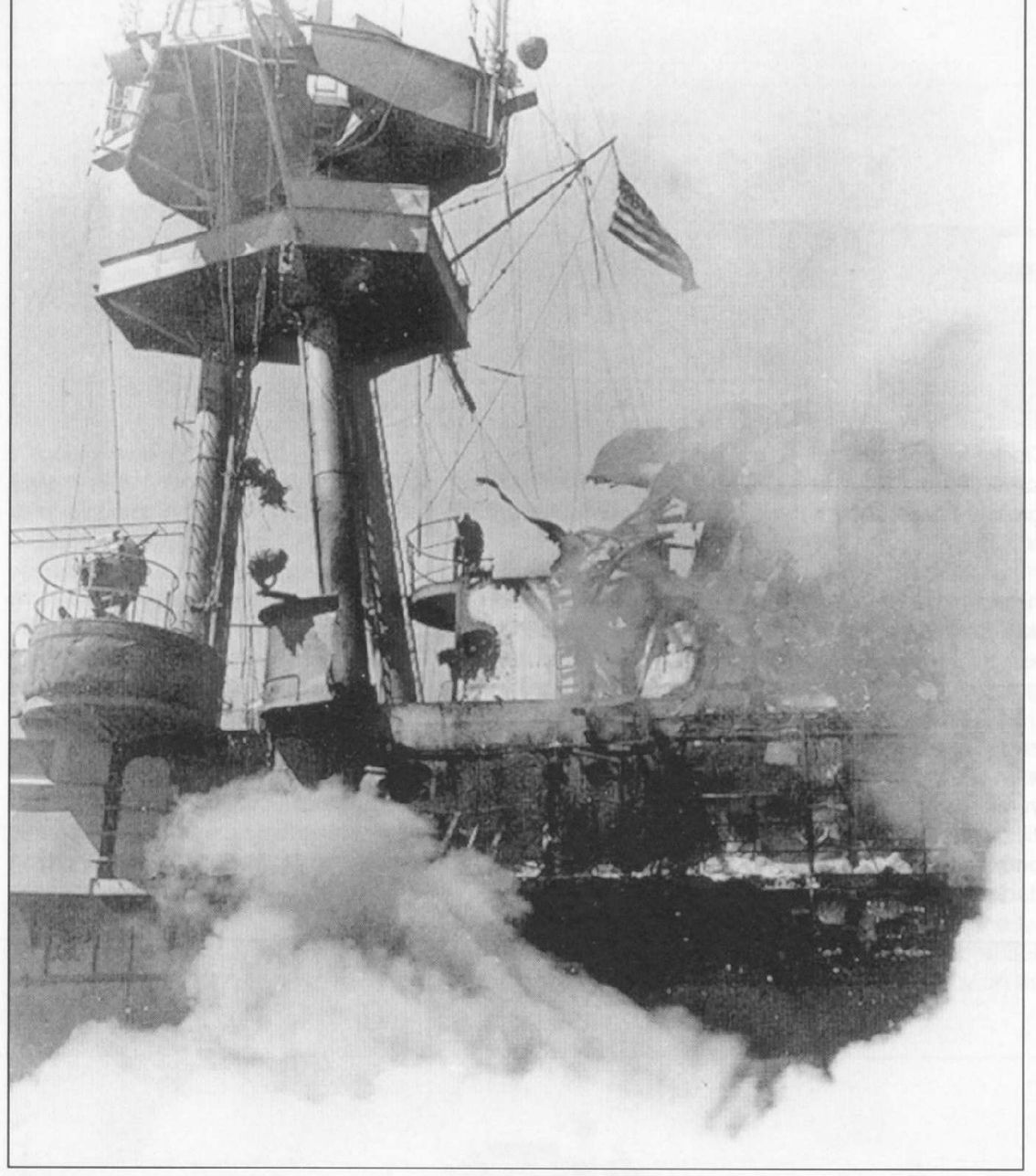
After the Tokyo raid, *Hornet* returned to Pearl Harbor in the company of *Enterprise*, and then the two carriers headed for the South Pacific; they arrived too late to participate in the Battle of the Coral Sea. Seen here from *Enterprise* on 15 May 1942, *Hornet* has a deck full of aircraft but no enemy on this day to strike. *(NARA)*

(Clockwise from above)
Hornet hurried back to Pearl Harbor when intelligence indicated that the Japanese were moving against Midway. A harbor tug edges the carrier toward her berth, late May 1942. The camouflage is showing serious wear along her waterline, particularly at her bow. *(NARA)*

There's no time to worry about appearances. There was only time to refuel and replenish the ship before she left again on 28 May. This bow-on view shows the two 20 mm mounts forward. The catwalk under the flight deck forward linked the port and starboard galleries. The DF loop was placed at the edge of the flight deck forward in order to minimize interference by the steel structure of the ship. *(NARA)*

Hornet's participation in the Battle of Midway is often forgotten because her aircraft had little success for a variety of reasons. She was not damaged that day and was able to recover many of *Yorktown*'s aircraft. She is seen here at approximately 1300 on the day of the battle, 4 June 1942, with only Wildcats on deck. Her torpedo squadron, VT-8, was destroyed attacking the Japanese, and her dive bombers turned the wrong way searching for the enemy fleet and were not yet back from the morning attack. The cruiser in the foreground is *Atlanta* (CL 51). *(NARA)*





(Clockwise from upper left)
Damaged by AA fire, this Val is on a death plunge toward *Hornet* at the Battle of Santa Cruz, 26 October 1942. Meanwhile a Kate passes up alongside the flight deck after dropping its torpedo. Smoke from an earlier bomb hit on her flight deck aft can be seen trailing off her stern. Within the span of five minutes, *Hornet* was hit by at least three bombs, two crashing aircraft, and two torpedoes. *(NARA)*

The aircraft seen diving in the last photograph hit the inboard face of *Hornet*'s funnel and continued on down to the flight deck, where two of its three bombs exploded. The damage to both the funnel and flight deck was extensive. On her foretop, the CXAM antenna fitted after Midway can be seen. *(NARA)*

Wreathed in smoke, *Hornet* is approached by *Russell* (DD 414) at approximately 1100, 26 October 1942. Having lost all power, three destroyers from *Hornet*'s screen helped by pouring water on the carrier's fires. The long swells made this dangerous work. A lone Japanese dive bomber attacked a few minutes later, interrupting this effort. *(NARA)*

The cruiser *Northampton* (CA 26) took *Hornet* under tow just after 1200, but the light tow line snapped after only a few minutes. She then waited off the carrier's bow for two hours while a heavier cable was laid out. Meanwhile, destroyers came alongside and took off wounded and any personnel not involved in firefighting or damage control. *(NARA)*

A small second Japanese attack arrived not long after *Northampton* resumed towing, forcing her to drop the tow line again. An arc of AA bursts off *Hornet*'s port side failed to protect her from the incoming Kates. *(NARA)*

The Japanese pilots displayed skill and courage. This one held on to its torpedo as it passed over *Northampton*, heading toward *Hornet*. Of three Kates that aimed their torpedoes at the carrier, only one obtained a hit, but that was enough to convince Capt. Charles P. Mason that *Hornet* could not be saved. *(NARA)*

Her list gradually increasing, Hornet was abandoned soon after this attack. Here, one of her escorting destroyers, possibly *Mustin* (DD 413), stands by to see if any more survivors might make it off the ship. At dusk, *Mustin* and *Anderson* (DD 411) left the sinking carrier to the Japanese. *(NARA)*

Moored alongside a hospital ship, Bountiful (AH 9), Enterprise's wounded were transferred where they could receive better care, 15 May 1945. The day before, Enterprise had been hit by a single kamikaze, which burned out her hangar forward and finally drove the gallant old lady out of the war. More than enough newer and bigger carriers were available to take her place, but none of them embodied the history of the U.S. Navy in the Second World War quite the way Enterprise did. (NHC)

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